

PB90-220641

Superfund Record of Decision (EPA Region 3): Greenwood
Chemical Site, Albemarle County, Newtown, Virginia
(First Remedial Action), December 1989

(U.S.) Environmental Protection Agency, Washington, DC

29 Dec 89





Superfund Record of Decision:

Greenwood Chemical, VA

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U.S. DEPARTMENT OF COMMERCE
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Table 1
CONCENTRATIONS OF INDICATOR CONTAMINANTS IN LAGOON 1 SOIL
Greenwood Chemical Site, Albemarle Co., Virginia

Location Sample Depth Date of Sampling	11 & 31 4-6 12/87		13 & 32 4-6 12/87		12 & 33 6-8 12/87		14 & 34 6-8 12/87		15 6-8 12/87		8-9.5 6-7.5 12/88		9-10.5 10-11.5 12/88		8-7 10-11.5 12/88		10-12 12/88		12-13.5 12/88		14-15.5 12/88		15-16.5 12/88		18-19.5 12/88		21-22.5 12/88	
	45.1	379	66.3	39.4	192	7.8 8	2 8	6.4 8	4.3 8	3.3 8	2.7 8	3.9 8	3.7 8	6.3 8	5.3 8	6.6												
Arsenic																												
Benzene	1.392	5.435		7.362	0.062	<3.2	<3.2	<4.1	<3.3	<1.7	<2.3	<3.3	<1.1	<1	<0.83	<3.5												
Chlorobenzene	14.131	21.666	2.099	39.963	3.21	<3.2	<3.2	<4.1	<3.3	<1.7	<2.3	<3.3	<1.1	<1	<0.83	<3.5												
Cyanide	0.167	106.9	277.2	478.4	376.5	<1.2	1.35	1.08	<1.1	1.06	1.3	<1.1	<1.1	<1.1	<1.0	<1.1												
Methylene chloride	1.318	1.396	0.201	5.818	0.621	1.3 48	1.1 48	2.4 48	1.9 48	1.1 48	1.2 48	<3.3	0.74 48	<1	0.39 48	<3.5												
Tetrachloroethene	17.608	29.086	0.915	27.277	1.365	1.4 J	<3.2	<4.1	<3.3	<1.7	<2.3	<3.3	<1.1	<1	<0.83	<3.5												
Trichloroethene				0.026		<3.2	<3.2	<4.1	<3.3	<1.7	<2.3	<3.3	<1.1	<1	<0.83	<3.5												
Total TCL PAHs	7.3	195.7	54.367	831.447	78.597	29.6	29	3036	618.3	2427	131.8	2.1	162.5	3.3	122	31.5												
Total Volatile TICs						5	4		22			0.7		2.2														
Total Semivolatile TICs						98	161	5500	1120	4500	305	33	460	65.9	360	136												

All concentrations in mg/kg (ppm)

Key to data qualifiers:

A plus value indicates parameter was not detected and that data concerning the quantitation limit were not available. A less than value indicates the parameter was not detected at the concentration shown.

No Compound detected in blank:

Data validation qualifiers were not available for EPA/IAI samples collected 12/87

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REPORT DOCUMENTATION PAGE		1. REPORT NO. EPA/ROD/R03-90/084	2.	3. Recipient's Accession No. PB 90 220641/AS
4. Title and Subtitle SUPERFUND RECORD OF DECISION Greenwood Chemical, VA First Remedial Action			5. Report Date 12/29/89	
7. Author(s)			6. Performing Organization Report No.	
8. Performing Organization Name and Address			10. Project/Task/Work Unit Number	
			11. Contract (C) or Grant (G) No. (C) (G)	
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460			13. Type of Report & Period Covered 800/000	
15. Supplementary Notes			14.	
16. Abstract (Limit: 200 words) The five-acre Greenwood Chemical site is a former chemical plant in Newton, Virginia. Adjoining lands to the east, west, and south are used for rural, residential and agricultural purposes, and the Blue Ridge Mountain Range bounds the site to the north. Ground water is used by all persons within a three-mile radius for drinking water purposes. The closest residential well is within 400 feet of the site, and the closest downgradient well is approximately 2,500 feet from the site. The chemical plant was used primarily for the production of industrial, pesticide, pharmaceutical, and photographic products from 1947 until 1985, and produced waste solvents including listed RCRA F002 and F005 wastes. Plant operations were terminated in April 1985, after a toluene fire killed four employees. Contaminated areas at the site include seven lagoons used to store wastewaters generated during plant operations, and a buried drum area. To mitigate threats due to contamination, EPA emergency response activities were conducted between 1987 and 1988. These activities included removing surface drums and other stored chemicals; excavating lagoon sludge from three lagoons and stabilizing the underlying soil before disposing of the treated soil onsite in a lined vault constructed in one of the lagoons; and capping a lagoon. This operable unit addresses approximately 1.5 acres of the most contaminated portions of the site including the contaminated soil associated with three of the former lagoons, a backfilled (Continued on next page)				
17. Document Analysis a. Descriptors Record of Decision - Greenwood Chemical, VA First Remedial Action Contaminated Medium: soil Key Contaminants: VOCs (benzene, PCE, TCE), other organics (PAHs), metals (arsenic), other inorganics (cyanide) b. Identifiers/Open-Ended Terms c. COSATI Field/Group				
18. Availability Statement		19. Security Class (This Report) None	21. No. of Pages 64	
		20. Security Class (This Page) None	22. Price	

(See ANSI Z39.18)

See Instructions on Reverse

OF 1000000000 1/8 (4-77)
(Formerly NBS-100)
Department of Commerce

Table 1-A

Estimated Maximum Concentrations of
Selected Tentatively Identified Compounds (TICs)
Detected in OU-1 Soils

	mg/kg
1-Naphthaleneacetic acid	770
1-Naphthalene acetonitrile	14,000
1-Naphthalene carbonitrile	500
N,N-Dimethyl-benzeneamine	600
Phenyl-2-pyridinyl methanone	4,000
N-Methyl-benzeneamine	200
2-Amino-5-chlorophenyl-phenyl-methanone	5,000
5H-indeno (1,2-b)pyridine	880
Unknown Napthalene derivatives	1,700
Totals unknown concentration	2,400

Source: Appendix A, Focused Feasibility Study

16. Abstract (Continued)

lagoon now referred to as the backfilled area, and contained chemicals in the buildings. A second operable unit will address the remainder of the site including additional soil and sediment, and ground water underlying and downgradient of the contaminated soil. The primary contaminants of concern affecting the soil are VOCs including benzene, PCE, and TCE; other organics including PAHs; metals including arsenic; and other inorganics including cyanide.

The selected remedial action for this operable unit includes excavation and offsite incineration of approximately 4,500 cubic yards of contaminated soil, backfilling with clean soil, and revegetating; removal of chemicals stored in onsite buildings; and surface water collection/diversion during remedy implementation. The estimated present worth cost for this remedial action is \$8,787,900. There are no O&M costs associated with the remedy for this operable unit.

1-a

Table 2

CONCENTRATIONS OF INDICATOR CONTAMINANTS IN LAGOON 2 SOIL Greenwood Chemical Site, Albemarle Co., Virginia														
SUBSTANCE/PARAMETER	Location		16 & 35		17 & 37		19 & 38		20		85		85	
	Sample Depth	Date of Sampling	0-2	12/87	0-2	12/87	2-4	12/87	2-4	12/87	4-5.5	1/89	8-9.5	1/89
Arsenic			47.100	44.500	12.200	23.400	34.400		2.000	2.400	2.700	1.100	1.400	1.400
Benzene			1.080	0.780	1.420	0.503	0.006		0.018	0.024	0.012	0.040	0.016	
Chlorobenzene			15.900	9.630	8.220	6.585	4.130		0.027	0.049	0.030	0.057	0.030	
Cyanide			409.300	421.600	51.470	47.840	32.350		134.000	469.000	117.000	27.500	2.400	
Methylene chloride			1.740	1.550	0.820	0.360	0.359		0.013	0.005	0.005	0.009	0.007	
Tetrachloroethene			0.930	0.161	1.200	4.192	0.810		<0.007	<0.007	<0.007	<0.007	<0.007	
Trichloroethene					0.036				<0.007	<0.007	<0.007	<0.007	<0.007	
Total TCL PAHs			228.567	123.800	54.180				0.82	1.50	1.30	0.57	0.55	
Total Semivolatile TICs									32.01	76.62	49.47	17.36	10.35	
Total Volatile TICs									3.21	2.42	3.37	1.69	0.58	

All concentrations in mg/kg (ppm)
Key to data qualifiers:
No value indicates parameter was not detected and that data concerning the quantitation limit were not available.
A less than value indicates the parameter was not detected at the concentration shown.
B= Compound detected in blend

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TO:

U.S. EPA
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DECLARATION FOR THE RECORD OF DECISION

Site Name and Location

Greenwood Chemical Site
Albemarle County
Newtown, Virginia

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Greenwood Chemical Site, in Newtown, Virginia, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document explains the factual and legal basis for selecting the remedy for this site.

The Virginia Department of Waste Management concurs with the selected remedy. The information supporting this remedial action decision is contained in the Administrative Record for this site.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial threat to public health, welfare, or the environment.

Description of the Selected Remedy

This Operable Unit is the first of two Operable Units for the site. The selected remedy for Operable Unit One (OU-1) shall remediate contaminated soils associated with three (3) former lagoons and a backfill area, and contained chemicals in buildings which have been determined to present a principal threat to human health and/or the environment at the site. The remainder of the site constitutes Operable Unit Two (OU-2) and includes additional soil, sediment, and groundwater. A remedy for OU-1 is expected to remove all soil contamination of concern from areas addressed by the remedy. As a result, long-term management of soils associated with OU-1 will not be necessary.

The major components of the selected remedy include the following:

- o Excavation of soil exceeding risk-based cleanup levels (estimated at 4,500 cubic yards);
- o Implementation of runoff controls during excavation;
- o Staging and screening of the excavated soil;
- o Transportation of contaminated soil to an offsite, high temperature, RCRA-permitted thermal treatment facility (incinerator);
- o Incineration of soil, stabilization of the ash (if necessary), and disposal of the ash in RCRA Subtitle C landfill;
- o Backfilling of the excavated areas with clean fill;
- o Coverage with topsoil and revegetation;
- o Removal/disposal of chemicals in onsite buildings.

Declaration of Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatment to permanently and significantly reduce toxicity, mobility, or volume as their principal element. Because this remedy will not result in hazardous substances remaining above health-based levels and will permit unlimited use, the five-year review will not apply to this action.


Regional Administrator
Environmental Protection Agency

12/29/89
Date

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Note: Portions of this document have been adapted from a Focused Feasibility Study (FFS) for the Greenwood Chemical Site, as prepared for the EPA by Ebasco Services, Inc. in August 1989.

I. SITE DESCRIPTION

The Greenwood Chemical Site is located in Albemarle County, between Waynesboro and Charlottesville, Virginia. The site comprises approximately five (5) acres at the foot of the Blue Ridge Mountain Range (Figure 1). Although the site is located less than 1/4 mile from Interstate Route 64, access is from Route 690 via Routes 250 and 796. The site entrance is near the center of the small village of Newtown, Virginia. The site is bounded by Route 690 and an east/west residential road to the north. Adjoining lands to the east, west, and south are mixed-use rural, residential and agricultural. The site slopes to the south-southeast.

A small tributary to Stockton Creek runs approximately 500 feet west of the site. In addition, a farm pond is located approximately 300 feet downgradient of the site. The depth of ground water underlying the site averages about 25 feet. All persons within a 3-mile radius use ground water for drinking water purposes. The closest residential well is located 400 feet from the site, while the closest downgradient well is approximately 2,500 feet from the site.

The layout of the site is shown in Figure 2. The main features include three primary chemical process buildings, seven former lagoons and a former buried drum area. Only Lagoons 4 and 5 contain liquids at this time.

Operable Unit One (OU-1) comprises approximately 1.5 acres located on the slope leading southward from the former process buildings (Figure 2). OU-1 includes components of the Greenwood Chemical Site which are believed to be a principal threat to human health and the environment. The specific components of OU-1 are containers of chemicals stored in the process buildings, and contaminated soils associated with former Lagoons 1, 2, and 3 and Backfill North.

Leftover chemicals formerly used in the manufacturing processes by the Greenwood Chemical Company are stored in drums and containers in the process buildings. An inventory of the drums and containers was conducted by The Environmental Protection Agency (EPA) in June 1988 and confirmed by EPA during inspections in June 1988 and June 1989. All the drums and containers in the buildings have been sorted by EPA in accordance with their chemical characteristics.

II. SITE HISTORY

Since the onset of operations in 1947, a variety of chemical products with applications in industrial, pesticide, pharmaceutical, and photographic processes have been manufactured at the site. Manufacturing operations ceased in 1985. A complete list of chemicals produced since 1947 is not available.

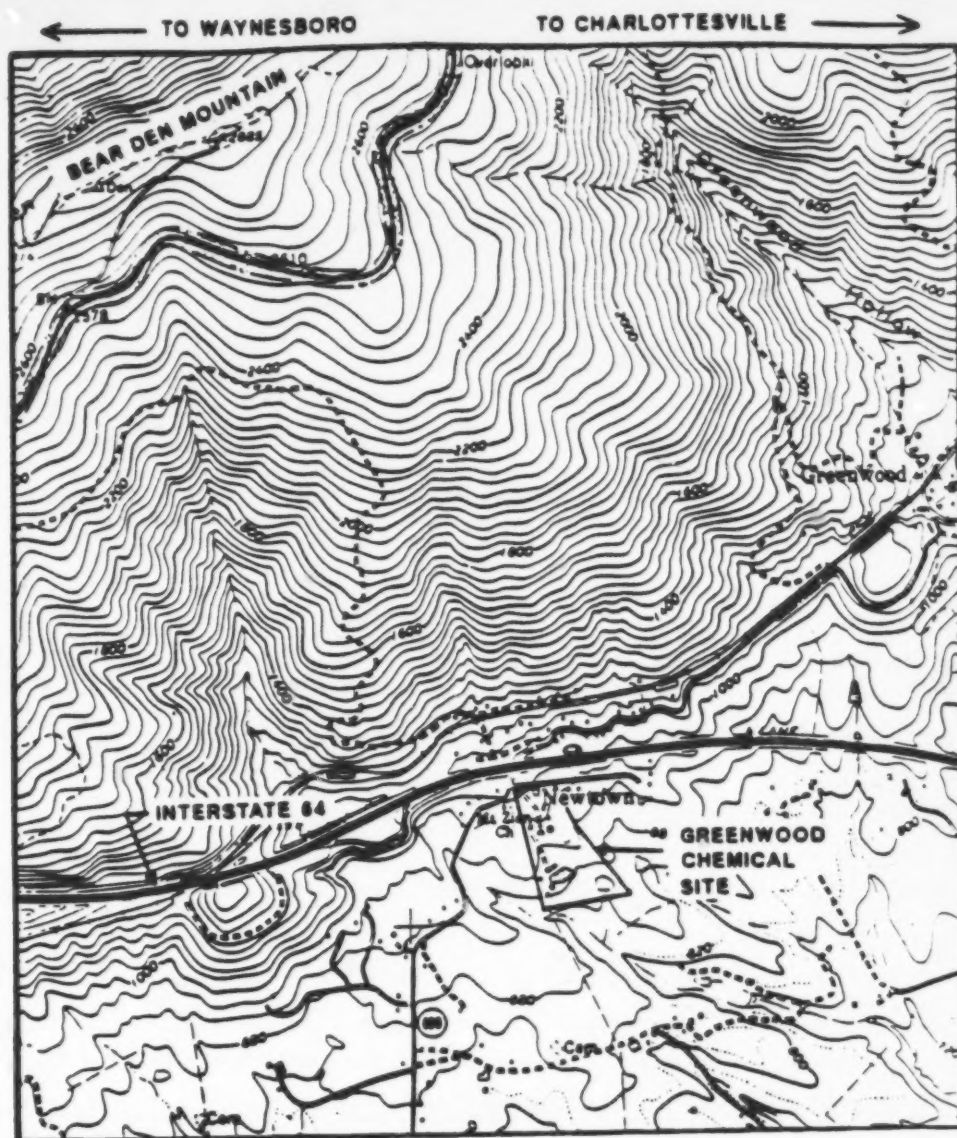
Primary products produced have included alpha naphthalene acetic acid, 1-naphthaldehyde, and naphthoic acid. Chemicals used in the production of naphthalene acetic acid included naphthalene derivatives, sodium cyanide, sulfuric acid, paraformaldehyde and hydrogen peroxide. The naphthalene derivative reportedly was reacted with sodium cyanide under alkaline conditions. In addition, inorganic arsenic salts were used onsite as catalysts in producing chloromethylnaphthalene, while dimethyl pyridine was used as a catalyst in the synthesis of polyurethane.

During the final years of operation (1982 to 1985), various naphthalene and benzene derivatives were produced and/or used in chemical processes. One of the three main buildings (Building C) was reportedly used for the following purpose:

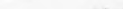
- o Production of naphthaldehyde via a proprietary process
- o Purification of the sodium salt of beta-naphthalene-sulfonic-acid
- o Production of 2-benzoyl pyridine by reacting 2-cyanopyridine in a solvent of monochlorobenzene
- o Dissolution of organic powder in toluene via another proprietary process

Waste solvents generated by the latter two processes are categorized as listed RCRA F002 and F005 wastes, respectively.

A list of chemicals used at the site between 1982 to 1984 was supplied by the Greenwood Chemical Co. to the Virginia Bureau of Toxic Substances. According to this inventory, between 10,000 and 100,000 kg of toluene and one-to-ten tons of cyanide per year were utilized by the Greenwood Chemicals Company during this time period. A list of 32 products was also supplied by Greenwood Chemical Co. This list contains products for sale and includes intermediate and final products related to pharmaceutical manufacturing, the agriculture industry, and the general synthesis of other products.



Scale feet



1000 0 1000 2000

1"=2000'

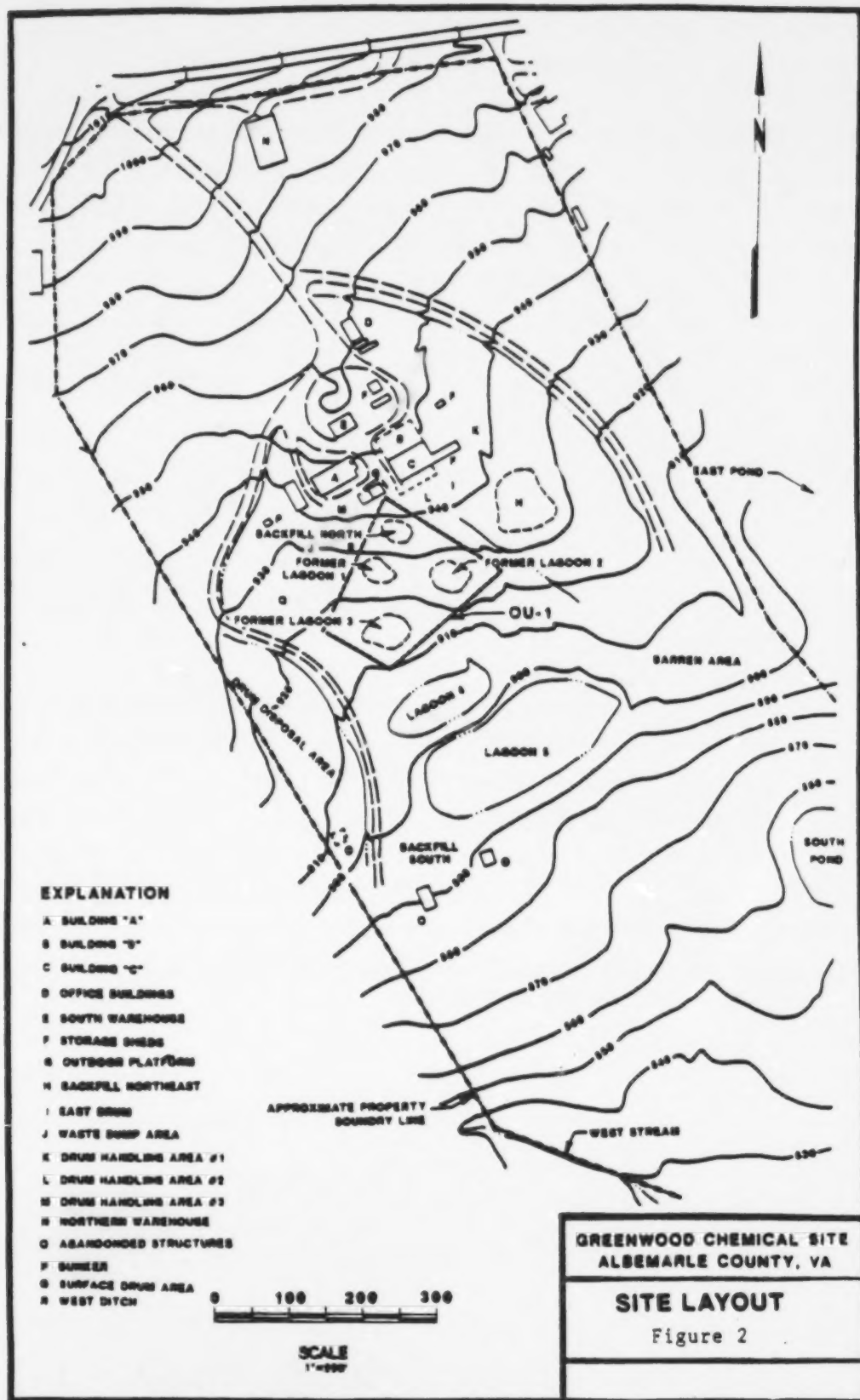


GREENWOOD CHEMICAL SITE
ALBEMARLE COUNTY, VIRGINIA

SITE LOCATION MAP

Figure 1

SOURCE: USGS Waynesboro East, VA Quadrangle



During the initial period of operations, wastewater from the manufacturing activities was discharged into a small lagoon which has since been backfilled. The EPA has designated this former lagoon Backfill North. Following closure of the Backfill North lagoon, wastewater from Building A was directed to Lagoon 1, while wastewater from Buildings B and C reportedly entered Lagoon 2. When these lagoons reached a predetermined level, wastewater was allegedly routed into Lagoon 3 through overflow pipelines. Lagoons 1, 2, and 3 did not incorporate any processes to aid in the breakdown of waste organic chemicals. Wastewater from Lagoon 3 was routed to Lagoon 4 and then to Lagoon 5. Lagoon 5 had spray devices to aid evaporation in order to prevent overflow. All five lagoons were unlined. In 1978, the lagoons were reportedly drained and bentonite liners were installed. Details concerning the construction methods, materials, or thickness of these liners could not be determined from available information. The Greenwood Chemical Co. was not classified by EPA or the Commonwealth of Virginia as a treatment, storage, or disposal facility under RCRA. In addition, at no time was the facility regulated under the NPDES program of the Federal Clean Water Act. The facility was issued a No-Discharge Certificate by the Virginia State Water Control Board (SWCB) pursuant to the Virginia State Water Control Law.

Operations at the plant were terminated in April 1985 when a toluene fire killed four workers. A Preliminary Assessment and a Hazard Ranking were performed in May and November 1985, respectively. The site was promulgated as a National Priorities List (NPL) site in July 1987.

EPA emergency response activities took place at the Greenwood Site over the next 18 months (1987-1988).

Specific details pertaining to removal activities conducted in 1987/1988 associated with OU-1 include:

- o A significant number of surface drums were removed from the site
- o Remaining drums and containers in the buildings were examined, inventoried, overpacked and stored for future removal/disposal
- o Potentially explosive materials detonated on the site.
- o Sludge from Lagoons 1, 2 and 3 was excavated and disposed of offsite. Underlying, highly-contaminated soil from Lagoons 1, 2, and 3 was stabilized with kiln dust, excavated, and placed in a lined vault in Lagoon 3

- o After excavation of contaminated sludge and soil, Lagoon 1 was covered with 3-to-4 feet of clean soil obtained from a borrow area west of Lagoon 1.

A Remedial Investigation/Feasibility Study was initiated in October 1988. A Focused Feasibility Study (FFS) addressing OU-1 was completed in August 1989.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Focused Feasibility Study (FFS) Report and the Proposed Plan for the Greenwood Chemical site were released to the public for comment on August 24, 1989. These two documents were made available to the public in both the Administrative Record and in an information repository maintained at the EPA Docket Room in Region III and at the Crozet Branch of the Jefferson-Madison Regional Library in Crozet, Virginia. The notice of availability for these two documents was published in The Charlottesville Daily Progress on August 24, 1989. A public comment period on the documents was held from August 24, 1989 to October 24, 1989. In addition, a public meeting was held on September 12, 1989. At this meeting, representatives from the EPA answered questions about problems at the site and the remedial alternatives under consideration. A response to the comments received during this period is included in the Responsiveness Summary, part of this ROD.

IV. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION WITHIN SITE STRATEGY

As with many Superfund sites, the problems at the Greenwood Chemical Site are complex. As a result, EPA has organized the remedial work into two Operable Units. Operable Unit One (OU-1) addresses contaminated soil associated with Lagoons 1, 2, and 3 and Backfill North. EPA has determined that these soils constitute a principal threat at the site. In particular, this soil has been determined to present an unacceptable risk from potential direct contact and an unacceptable risk to potential or known consumers of groundwater. Operable Unit Two (OU-2) includes remaining soil/sediment and groundwater/surface water. This ROD addresses OU-1, while a follow-up ROD will address OU-2.

V. Sources of Contamination in OU-1

Lagoon 1

During EPA removal activities in 1987 and 1988, contaminated sludges from Lagoon 1 were excavated and removed from the site. Contaminated soils below the sludge remained to be addressed by means of a remedial action. The Lagoon 1 excavation was backfilled with clean site soils in the interim. The area of Lagoon 1 is an estimated 1570 square feet.

Sixteen (16) soil samples have been collected and analyzed from Lagoon 1. Five (5) of these samples were collected during USEPA removal activities at the site in December 1987; the remaining eleven (11) samples were obtained from two soil borings (B6 and B7) completed in Lagoon 1 in December 1988, during the RI/FS field program performed by EPA.

Analytical results for significant contaminants detected in Lagoon 1 soils are summarized in Table 1. The complete analytical results are summarized in Appendix A of the FFS.

These results reveal elevated levels of benzene, methylene chloride, tetrachloroethene, and arsenic from 0 to 4 feet in depth from interface of the fill and the original soil profile. Samples collected from 4 to 15.5 feet from this interface revealed highly elevated levels of both volatile and semi-volatile Tentatively Identified Compounds (TICs). The semi-volatile TIC naphthaleneacetonitrile was detected at estimated levels of up to 5500 mg/kg within this zone. Table 1-A summarizes estimated maximum concentrations of selected Tentatively Identified Compounds detected in OU-1 soils, i.e., soils of Lagoons 1, 2, and 3, and Backfill North.

Lagoon 2

Soil samples were collected from Lagoon 2 during EPA removal activities and the RI/FS field program. Five (5) soil samples were collected from surface (0-2 feet) and near-surface (2-4 feet) soils in December 1987; five (5) additional soil samples were obtained from a soil boring (B5) completed in January 1989. Selected results for the indicator contaminants are presented in Table 2. The complete analytical results for Lagoon 2 soils are summarized in Appendix A of the FFS. The area of Lagoon 2 was approximately 2,356 square feet.

Elevated levels of benzene, methylene chloride, tetrachloroethene and arsenic were detected in soils at least to a depth of four feet within this area. In addition, elevated levels of the volatile TIC tetrahydrofuran were detected in soils up to 20 feet in depth.

Table 3

CONCENTRATIONS OF INDICATOR CONTAMINANTS IN LAGOON 3 SOIL AND VAULT CONTENTS
Greenwood Chemical Site, Albemarle Co., Virginia

	Sample Number Sample Depth Origin (a) Date of Sampling	30 Vault Lagoon 1 12/87	26 Vault Lagoon 2 12/87	27 Vault Lagoon 2 12/87	28 Vault Lagoon 3 12/87	29 Vault Lagoon 3 12/87	513-1 Vault 12/88	513-2 Vault 12/88	21 & 39 8-10 12/87	25 & 40 8-10 12/87
Arsenic		58	47	39.2	78.9	148	18 K	252 K	35	57.2
Benzene		5.308	0.399	4.29	0.027	0.008	<210	<30		
Chlorobenzene		19.992	1.531	9.639	1.332	0.333	150 J	<30		0.16
Cyanide			48.39	17.34	63.8	27.68	205.51	14.51	1.953	29.74
Methylene chloride		2.342	0.724	0.528	0.395	0.514	<210	9.1 B	0.228	0.479
Tetrachloroethene		4.044	0.1	1.082	0.162	0.024	<210	10 J		0.009
Trichloroethene		0.059					<210	<30		
Total TCL PAHs		804.9	58.3	263.2	64.3	155.2		890	17.41	
Total Semivolatile TICs							14308	3088		
Total Volatile TICs							100			

All concentrations in mg/kg (ppm)

Key to data qualifiers:

No value indicates parameter was not detected and that data concerning the quantitation limit were not available.
A less than value indicates the parameter was not detected at the concentration shown.

J= Estimated concentration

B= Compound detected in blank

R= Rejected value

L= Biased low due to low spike or surrogate recovery

K= Biased high due to high spike or surrogate recovery

Data validation qualifiers were not available for EPA/IAI samples collected 12/87 and 4/88.

(a) Material was sampled after excavation from indicated source area, prior to placement in the vault
(EPA/IAI samples 26-30 only).

Table 3 (cont.)

CONCENTRATIONS OF INDICATOR CONTAMINANTS IN LAGOON 3 SOIL AND VAULT CONTENTS
Greenwood Chemical Site, Albemarle Co., Virginia

	Sample Number Sample Depth Origin (a) Date of Sampling	E1-9 9 4/88	22 & 41 10-12 12/87	24 & 42 10-12 12/87	25 10-12 12/87	E1-10 10 4/88	E1-11 11 4/88
Arsenic		73.2	22	32.3	16.5	23.2	13.9
Benzene		<0.005				<0.005	<0.005
Chlorobenzene		<0.005		0.036		<0.005	<0.005
Cyanide		21	0.349	5.7	0.298	32	30
Methylene chloride		<0.01	0.338	0.773	0.719	<0.01	<0.01
Tetrachloroethene		<0.005				<0.005	<0.005
Trichloroethene		<0.005				<0.005	<0.005
Total TCL PAHs			29.2	0.45			
Total Semivolatile TICs							
Total Volatile TICs							

All concentrations in mg/kg (ppm)

Key to data qualifiers:

No value indicates parameter was not detected and that data concerning the quantitation limit were not available.
A less than value indicates the parameter was not detected at the concentration shown.

J- Estimated concentration

B- Compound detected in blank

R- Rejected value

L- Blended low due to low spike or surrogate recovery

H- Blended high due to high spike or surrogate recovery

Data validation qualifiers were not available for EPA/IAL samples collected 12/87 and 4/88.

(a) Material was sampled after excavation from indicated source area, prior to placement in the vault
(EPA/IAL samples 26-38 only)

Table 4

CONCENTRATIONS OF INDICATOR CONTAMINANTS IN BACKFILL NORTH SOIL
Greenwood Chemical Site, Albemarle Co., Virginia

	LOCATION Sample Depth Date of Sampling	183 0-3.5 10/87	183 4-6 10/87	82 4-6 2/89	82 6-7.5 2/89	183 6-8 10/87	82 10-11.5 2/89	82 14-15.5 2/89	82 17.5-19 2/89
Arsenic		113	687	18.6		496	4.6 B	3 B	6.5 B
Benzene				<0.86	<0.84	0.017 J	<0.79	<0.90	<0.82
Chlorobenzene				<0.86	<0.84		<0.79	<0.90	<0.82
Cyanide		43	357	7.5	1.2	16	5.8	1.1	1.3
Methylene Chloride		0.048 B		<0.86	<0.84		<0.79	<0.90	<0.82
Tetrachloroethene				<0.86	<0.84		<0.79	<0.90	<0.82
Trichloroethene				<0.86	<0.84		<0.79	<0.90	<0.82
Total TCL PAHs		0.58	0.48	360	490	0.59	13	9.2	0.73
Total Volatile TICs (None detected)									
Total Semivolatile TICs		17623		1690	2262	1259	303	378	199

All concentrations in mg/kg (ppm)

Key to qualifiers:

No value indicates parameter was not detected and that data concerning the quantitation limit were not available.
A less than value indicates the parameter was not detected at the concentration shown.

J= Estimated concentration

B= Compound detected in blank

R= Rejected value

L= Blinded low due to low spike or surrogate recovery

H= Blinded high due to high spike or surrogate recovery

Lagoon 3

Fifteen (15) soil samples were collected and analyzed from Lagoon 3 during removal activities in December 1987 and April 1988, and the RI/FS field program in December 1988. Seven (7) of these samples represent the contaminated materials excavated from Lagoons 1, 2, and 3 and encapsulated in the "vault" constructed in the Lagoon 3 excavation. The materials stored within the vault have been classified as soils based on site observations. In particular, sampling in December 1988 confirmed that there were no sludges observed in the vault, only dry to slightly moist, silty clay with gravel and small kiln dust concretions.

The remaining eight (8) soil samples from Lagoon 3 were obtained from the 8-12 foot depth interval, which corresponds to the first four feet of soil underlying the vault. Selected results for the indicator contaminants are presented in Table 3. The complete analytical results for Lagoon 3 soil samples are summarized in Appendix A of the FFS. The area of Lagoon 3 is an estimated 3,024 square feet.

Soils within the vault were found to contain elevated levels of benzene, tetrachloroethene, methylene chloride and arsenic. In addition, fifteen (15) volatile/semi-volatile TICs were detected in these soils. Total semi-volatile TICs were detected at levels up to 14300 mg/kg. Soils up to four feet below the bottom of the vault were found to contain elevated levels of methylene chloride.

Backfill North

A total of eight (8) soil samples were collected from the Backfill North (BFN) area. Three (3) samples were obtained from a boring of 8 feet completed during the September 1987 interim field investigation. The remaining five samples were collected from a 19-foot-deep boring drilled in February 1989 for the RI/FS field program.

Summarized results for the indicator contaminants detected in these eight (8) samples are presented in Table 4. Complete analytical results for BFN soil samples are summarized in Appendix A of the FFS. The area of Backfill North is an estimated 570 square feet.

Containerized Chemicals

Chemicals formerly utilized in chemical processes onsite remain stored in onsite process buildings. An inventory of the chemicals of concern has been compiled by EPA and verified by EPA periodic inspection. The inventory includes an estimated 400 containers of chemicals, ranging in volume from 60 milliliters to 55 gallons. The identity of these chemicals has been determined to be business-confidential information. However, EPA's analysis of this inventory has determined that the chemicals of concern

are either carcinogenic or toxic, and present a threat to human health from dermal contact or incidental ingestion.

VI. CONTAMINANT MIGRATION

Sampling during RI/FS activity has revealed significant contamination of groundwater underlying and downgradient of contaminated soils associated with Lagoons 1, 2 and 3 and Backfill North. Figure 3 indicates the location of monitoring wells, while Table 5 summarizes the results of sampling conducted by EPA in February 1989.

Sampling of Monitoring Well 10D, located immediately south of former Lagoon 1, revealed significant concentrations of benzene, chlorobenzene, tetrachloroethene and semi-volatile TICs. Sampling of Monitoring Well 18S and 18D, located approximately 150 feet downgradient of Lagoon 2 in the direction of groundwater flow (to southeast) revealed significant concentrations of benzene, chlorobenzene, trichloroethene, semi-volatile TICs and volatile TIC's.

As previously indicated, all persons within a three-mile radius of the site currently utilize groundwater for drinking water purposes. The closest downgradient residential well is located approximately 2,500 feet from the site. In addition, all residential wells within a 3-mile radius of the site are potentially hydraulically connected to ground water underlying the site. The referenced sampling results indicate contaminated soils associated with Lagoons 1, 2, and 3, and Backfill North have contaminated ground water underlying and downgradient (southeast) of the site. In addition, while contaminated groundwater is not known to have impacted surface water through recharge, this is a pathway of potential concern. A remedy addressing contaminated groundwater shall be selected in a follow-up ROD for OU-2.

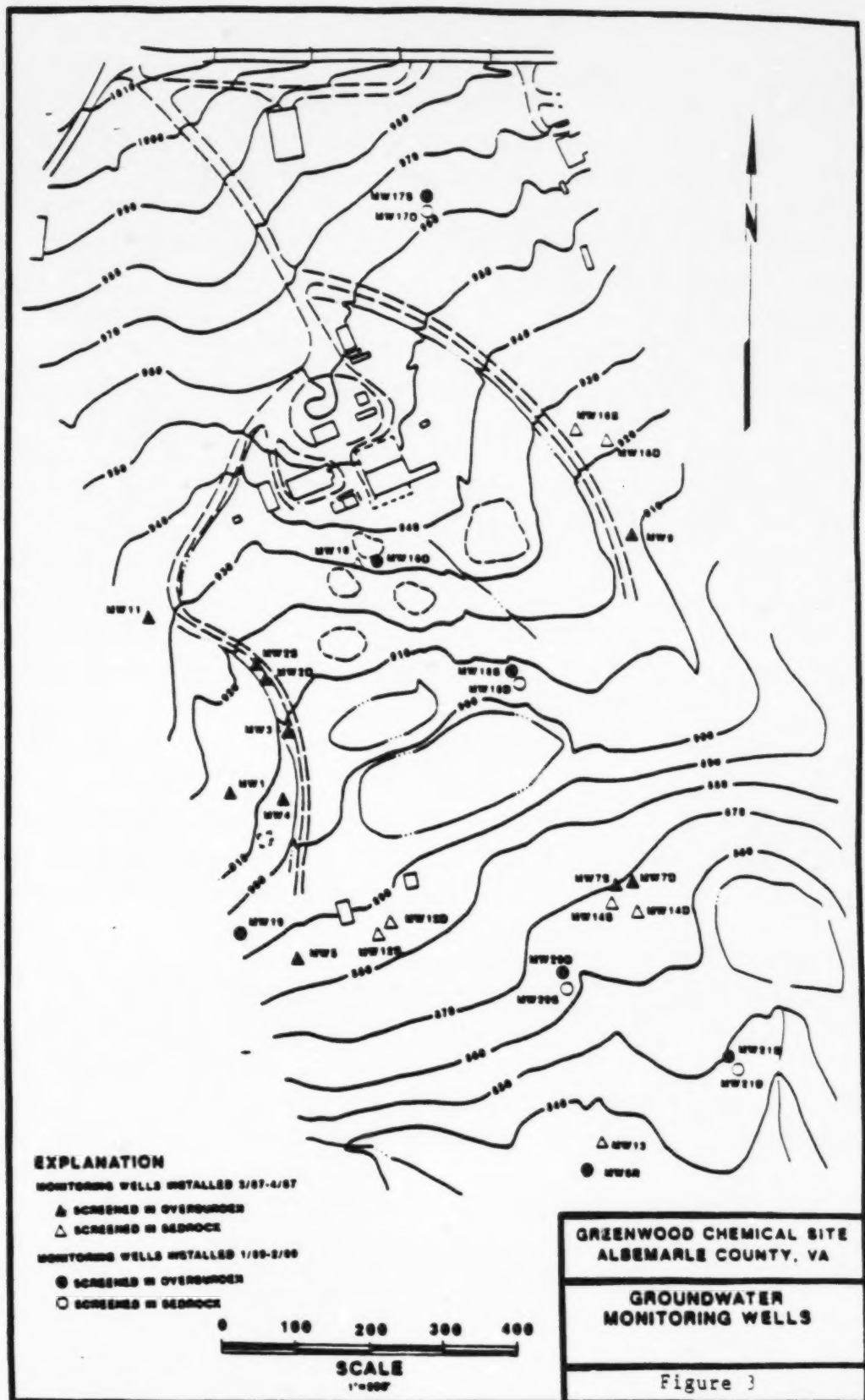


Table 5

FEBRUARY 1985 GROUNDWATER MONITORING DATA
Greenwood Chemical Site, Albemarle, Co., Virginia

CONTAMINANT	MONITORING WELL													GROUNDWATER QUALITY STANDARD			
	M01	M02B	M02D	M03	M04	M05	M06A	M07B	M07D	M09	M010D	M011	M012B	M012D	M013	Safe Drinking Water Act	Virginia State Control Law
Arsenic (total)							1.5				5.8					50	50
Arsenic (dissolved)																	
Benzene	230				54						11					5	
Chlorobenzene	97			1 J	72						130					100 *	
Cyanide (total)										40							5
Cyanide (dissolved)																	
Methylene Chloride	28				5.8				1.8				3.8				
Tetrachloroethene	8			1 J	7		5				25					5 *	
Trichloroethene	25				6		7		5						2 J	5	
Total TCL Semivolatiles	94	6		115	74	5	9	4	20		10	3	3				
Total Semivol. TICs			123	65.4			265		556	42	5750			308	17		
Total Volatile TICs	510			180	48.3										19		

Notes: All concentrations are in ug/l (ppb)

No value indicates parameter was not detected

J - Estimated value

B - Compound found in blank; detected at concentration shown

* - Proposed standards

Table 5

(Cont. Inued)

FEbruary 1989 GROUNDWATER MONITORING DATA
Greenwood Chemical Site, Albemarle, Co., Virginia

CONTAMINANT	MONITORING WELL													GROUNDWATER QUALITY STANDARD	
	MM101	MM102	MM103	MM104	MM105	MM106	MM107	MM108	MM109	MM110	MM111	MM112	MM113	Safe Drinking Water Act	Virginia State Control Law
Arsenic (total)	2.8														
Arsenic (dissolved)															
Benzene															
Chlorobenzene	31	26													
Cyanide (total)															
Cyanide (dissolved)															
Methylene Chloride															
Tetrachloroethene															
Trichloroethene															
Total PCL Semivolatiles	43	30	2												
Total Semivol. TICs	1175	169	160	410	46										
Total Volatile TICs															

Notes: All concentrations are in ug/l (ppb)

No value indicates parameter was not detected

J - Estimated value

B - Compound found in blank; detected at concentration shown

* - Proposed standards

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VII. SUMMARY OF SITE RISKS

A Baseline Risk Assessment has been performed to estimate the risk to human health posed by contaminated soils in OU-1. Based on RI data, the soils of concern were determined to present a potential risk to human health by contamination of groundwater (and subsequent ingestion of groundwater by persons potentially residing at or near the site boundary) and from direct contact by potential future residents. The Baseline Risk Assessment has therefore estimated risk posed to human health by contaminated soil in OU-1 through these two pathways.

Eleven (11) chemicals/substances were selected as primary chemicals/substances of concern: benzene, trichloroethene, chlorobenzene, tetrachloroethene, methylene chloride, noncarcinogenic polycyclic aromatic hydrocarbons (PAH) (represented by naphthalene), naphthalene acetic acid, naphthylacetonitrile, tetrahydrofuran, arsenic, and cyanide. These chemicals were found at relatively high concentration and frequency in site soils.

The organic chemicals, benzene, methylene chloride, tetrachloroethene, and trichloroethene represent the volatile carcinogenic solvents, while chlorobenzene, methylene chloride and tetrachloroethene represent the volatile non-carcinogenic solvents. Naphthalene represents the measured constituents of the non-carcinogenic semivolatile class of PAH.

Naphthalene acetic acid, naphthylacetonitrile, and tetrahydrofuran are several of many tentatively identified compounds (TICs) that have been observed at the Greenwood Site in relatively high concentrations. These particular compounds are expected to exhibit non-carcinogenic chronic systemic toxicity; however, the actual toxicological implications of these and other TICs are difficult to assess due to the paucity of data available concerning these chemicals. Methylene chloride and tetrachloroethene are represented in both of the groups because they have been shown to exhibit both carcinogenic and non-carcinogenic effects. For the inorganic chemicals of concern, arsenic represents carcinogenic metals and cyanide represents noncarcinogenic anions.

To facilitate estimation of risk posed by the soils of concern to potential consumers of groundwater at or near the site boundary, mean and maximum concentrations of the primary contaminants of concern in OU-1 soils were calculated. These concentrations appear in Table 6. A soil leaching model was then used to estimate the resultant concentrations of these compounds in groundwater at the site boundary. The model of concern is described in Appendix D of the FFS. Estimated mean and maximum concentrations of these compounds in groundwater as calculated via the model are presented in Table 7.

Utilizing the mean and maximum concentrations in Table 7, an excess upper bound lifetime cancer risk and ratio of chronic daily intake (DI) to reference dose (RFD) were calculated for carcinogens and non-carcinogens, respectively. Both average and plausible maximum risks and ratios were calculated. Cancer potency factors were used to calculate carcinogenic risk. The estimated risks of concern are summarized in Table 8.

Cancer potency factors (CPFs) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of (mg/kg-day), are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals, that is not likely to be without an appreciable risk of adverse health effects. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfDs. RfDs are derived from human epidemiological studies, or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse non-carcinogenic effects to occur.

Excess lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one-in-one-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site.

Potential concern for non-carcinogenic effects of a single contaminant in a single medium is expressed as the Hazard Quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminants's reference dose). By adding the HQs for all contaminants within a medium, or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. A Hazard Index of one (1) or greater would indicate adverse, non-carcinogenic health impacts could occur.

For certain chemical classes observed at the Greenwood Chemical site (e.g., polycyclic aromatic hydrocarbons (PAH) and tentatively identified compounds (TICs), human health information is very limited. Because of this paucity of data, it is necessary to assign a representative chemical, having human health information, to represent the entire chemical group. Thus, for the purposes of this baseline risk assessment, naphthalene will represent total PAH on the target compound list, naphthalene acetic acid will represent total semi-volatile TICs, and tetrahydrofuran will represent total volatile TICs.

As reflected in Table 8, leaching of contaminants from OU-1 soils is estimated to result in ground water which exceeds the 10^{-6} carcinogenic risk level in both the average (6×10^{-4}) and plausible maximum (2×10^{-2}) cases if consumed on a regular basis. (See Table 6 for soil contaminant levels used to calculate average and plausible maximum cases.) The actual carcinogenic risk associated with this pathway may be between the average and plausible maximum case. In the case of non-carcinogens, the calculated hazard index exceeded a value of one for both the average and plausible maximum cases for the groundwater pathway.

In addition to the ground water pathway, baseline risk due to direct contact with the contaminated soils of OU-1 has also been estimated. The risk of concern is that incurred by potential future residents of the site from incidental ingestion and dermal contact. The soils of concern were assumed to be those within five (5) feet of the surface. Table 9 indicates the mean and maximum concentrations of the contaminants of concern in surface soils. Table 10 summarizes estimated risk and hazard index (CDI:RfD) for carcinogens and non-carcinogens. Assumptions and calculations are summarized in Appendix D of the FFS.

Table 6

SOIL* EXPOSURE POINT CONCENTRATIONS USED IN THE
SOIL LEACHING MODEL FOR THE INGESTION
OF GROUND WATER PATHWAY (in mg/kg)

Chemical	Mean Concentration	Maximum Concentration
Arsenic	26.1	687
Total Cyanide	22.3	478
Benzene	0.24	7.30
Chlorobenzene	1.38	150
Methylene Chloride	0.23	9.1
Tetrachloroethene	0.51	27.3
Trichloroethene	0.014	0.059
PAHs (naphthalene)	45.9	3,300
TICs (naphthalene acetic acid)	1,560	17,600
TICs (tetrahydrofuran)	1.39	2.50

*Surface soil concentrations and subsurface soil concentrations were combined.

Table 7
POTENTIAL GROUNDWATER CONCENTRATIONS AT THE GREENWOOD CHEMICAL SITE
ESTIMATED FROM THE SOIL LEACHING MODEL (in mg/L)

Chemical	Mean Concentration	Maximum Concentration
Arsenic	0.014	0.37
Total Cyanide	0.0065	0.14
Benzene	0.014	0.44
Chlorobenzene	0.021	2.3
Methylene Chloride	0.13	5.2
Tetrachloroethene	0.0070	0.38
Trichloroethene	0.00055	0.0024
PAHs (naphthalene)	0.24	18
TICs (naphthalene acetic acid)	8.3	94
TICs (tetrahydrofuran)	0.70	1.25

Table 8
ESTIMATED EXPOSURE AND RISK ASSOCIATED WITH INGESTION
OF GROUNDWATER FROM SOIL LEACHATE

a. carcinogens

COMPOUND	CONCENTRATION (mg/l)		ESTIMATED CHRONIC DAILY INTAKE (CDI) (mg/kg/day)		CANCER POTENCY FACTOR (mg/kg/day) ⁻¹	EXCESS UPPER BOUND LIFETIME CANCER RISK	
	Geometric Mean	Maximum	Average	Plausible Maximum		Average	Plausible Maximum
Arsenic	1.4E-02	3.7E-01	3.4E-04	9.0E-03	1.75E+00	6E-04	2E-02
Benzene	1.4E-02	4.4E-01	4.2E-04	1.3E-02	2.90E-02	1E-05	4E-04
Chloride	1.3E-01	5.2E+00	3.9E-03	1.6E-01	7.50E-03	3E-05	1E-03
Tetrachloroethene	7.0E-03	3.0E-01	2.1E-04	1.2E-02	5.10E-02	1E-05	6E-04
Trichloroethene	5.5E-04	2.4E-03	1.7E-05	7.3E-05	1.10E-02	2E-07	8E-07
TOTAL:						6E-04	2E-02

b. noncarcinogens

COMPOUND	CONCENTRATION (mg/l)		ESTIMATED CHRONIC DAILY INTAKE (CDI) (mg/kg/day)		REFERENCE DOSE (RfD) (mg/kg/day)	CDI RfD	
	Geometric Mean	Maximum	Average	Plausible Maximum		Average	Plausible Maximum
Cyanide	6.5E-03	1.4E-01	2.0E-04	4.2E-03	2.00E-02	1E-02	2E-01
Chlorobenzene	2.1E-02	2.3E+00	6.3E-04	7.0E-02	3.00E-02	2E-02	2E+00
Methylene Chloride	1.3E-01	5.2E+00	3.9E-03	1.6E-01	6.00E-02	7E-02	3E+00
Tetrahydrofuran	6.9E-01	1.2E+00	2.1E-02	3.0E-02	1.30E-02	2E+00	3E+00
PAHs (naphthalene)	2.4E-01	1.0E+01	3.6E-03	2.7E-01	4.00E-01	9E-03	7E-01
VOCs (naphth. ac. acid)	8.3E+00	9.4E+01	1.3E-01	1.4E+00	4.70E-02	3E+00	3E+01
HAZARD INDEX:						>1 (5E+00)	>1 (6E+02)

TABLE 9

CONCENTRATION OF CHEMICALS OF CONCERN DETECTED IN SURFACE SOILS
AT THE GREENWOOD CHEMICAL SITE (in mg/kg)

Chemical	Mean Concentration	Maximum Concentration
Arsenic	50.3	252
Total Cyanide	60.9	422
Benzene	0.31	5.39
Chlorobenzene	6.82	150
Methylene Chloride	0.73	9.1
Tetrachloroethene	0.66	4.19
Trichloroethene	0.046	0.059
PAHs (naphthalene)	155	985
TICs (naphthalene acetic acid)	9,210	17,600
TICs (tetrahydrofuran)	ND	

ND - Not detected in surface soils.
Surface soils: 0 - 5 feet

Table 10

ESTIMATED EXPOSURE AND RISK ASSOCIATED WITH DIRECT CONTACT WITH SURFACE SOIL
BY RESIDENTS LIVING ON THE GREENWOOD CHEMICAL SITE

a. carcinogens

COMPOUND	SOIL CONCENTRATION (mg/kg)		ESTIMATED CHRONIC DAILY INTAKE (CDI) (mg/kg/day)				CANCER POTENCY FACTOR (mg/kg/day) ⁻¹	EXCESS UPPER BOUND LIFETIME CANCER RISK	
	Average	Plausible Maximum	INCIDENTAL INGESTION		DERMAL ABSORPTION			Average	Plausible Maximum
			Average	Plausible Maximum	Average	Plausible Maximum			
Arsenic	5.03E-01	2.52E+02	1.01E-05	5.06E-05	1.19E-06	5.90E-06	1.75E+00	2E-05	1E-04
Benzene	3.10E-01	5.39E+00	7.70E-08	1.35E-06	7.35E-08	1.20E-06	2.90E-02	4E-09	0E-08
Methylene Chloride	7.30E-01	8.10E+00	1.83E-07	2.20E-06	1.73E-07	2.16E-06	7.50E-03	3E-09	3E-08
Tetrachloroethene	6.60E-01	4.10E+00	1.00E-07	1.05E-06	1.50E-07	9.93E-07	5.10E-02	2E-08	1E-07
Trichloroethene	4.00E-02	5.00E-02	1.15E-08	1.40E-08	1.09E-08	1.40E-08	1.10E-02	3E-10	3E-10
TOTAL :								2E-05	1E-04

b. noncarcinogens

COMPOUND	ESTIMATED CHRONIC DAILY INTAKE (CDI) (mg/kg/day)						REFERENCE DOSE (mg/kg/day)	CDI R/D	
	SOIL CONCENTRATION (mg/kg)		INCIDENTAL INGESTION		DERMAL ABSORPTION			Average	Plausible Maximum
	Average	Plausible Maximum	Average	Plausible Maximum	Average	Plausible Maximum			
Cyanide	6.00E+01	4.27E+02	1.22E-05	8.40E-05	1.44E-06	1.00E-05	2.0E-02	7E-04	5E-03
Chlorobenzene	8.02E+00	1.50E+02	1.71E-06	3.77E-05	1.62E-06	3.50E-05	3.0E-02	1E-04	3E-03
Methylene Chloride	7.30E-01	8.10E+00	1.83E-07	2.20E-06	1.73E-07	2.16E-06	6.0E-02	6E-06	7E-05
Phthalic anhydride	1.50E+02	9.05E+02	2.00E-05	1.20E-04	2.05E-05	1.07E-04	4.0E-01	1E-04	0E-04
Phthalic acid	9.21E+03	1.70E+04	1.20E-03	2.20E-03	1.75E-03	3.34E-03	4.7E-02	6E-02	1E-01
HAZARD INDEX:								<1 (6E-02)	<1 (1E-01)

As reflected in Table 10, the primary risk from direct contact is due to elevated levels of arsenic in surface soils. The average excess upper bound lifetime cancer risk in this case is 2×10^{-5} , while the plausible maximum may be as high as 1×10^{-4} .

In conclusion, contaminated soils associated with Lagoons 1, 2, and 3, and Backfill North present an unacceptable risk to human health from both the groundwater and direct contact pathways. It should be noted the risks identified in Table 8 and Table 10 should be considered conservative estimates. For instance, exposure levels may be overestimated and the criteria for health effects have margins of uncertainty.

A review of available site-related data has not revealed an environmental risk of concern. Extensive sampling of a tributary to Stockton Creek located approximately 500 feet from the site has detected no contaminants associated with the site. One sampling event did reveal an estimated 12 ug/l of cyanide in a farm pond located 300 feet south of Lagoon 5. Although the source of contamination is uncertain, available information suggests the source of this contamination is surface runoff from areas outside the scope of OU-1. Therefore, alternatives to address this potential problem shall be evaluated as part of Operable Unit Two. No critical habitats, endangered species or wetlands have been determined to be affected by the site.

Based on the above findings, actual or threatened releases of hazardous substances from the site (OU-1), if not addressed by implementing the response section selected in this ROD, may present an imminent and substantial endangerment to public health, welfare or the environment.

VIII. REMEDIAL ACTION OBJECTIVES

The objective of remedial action that addresses soils associated with Lagoons 1,2 and 3 and Backfill North (OU-1) is to minimize risk to human health and the environment, and in particular, to minimize exposure from the direct contact--incidental ingestion and dermal contact--and ingestion of ground water contaminated by leachate migrating from the soils of concern. Exposure from both of these pathways, under certain circumstances, may be reduced by placement of a permanent, impermeable cap over the soil of concern. However, in this case, erosional processes induced by the steep terrain characteristic of the site prevent placement of a permanent cap. Placement of a cap which is unlikely to be permanent does not conform with SARA's preference for permanent solutions. The alternative is removal from the site of all soil determined to exceed site-specific, risk-based cleanup levels.

Site-specific risk-based cleanup levels protective of the groundwater ingestion pathway are presented in Table 11. Target concentrations protective of this pathway were developed from models to determine base-line risk. Specific calculations can be found in Appendix B of the FFS. To avoid exceeding ground water criteria identified in Table 11, all soils above target concentrations in this Table will be removed from the site. In all cases, with one exception, criteria protective of the groundwater pathway are also protective of the direct contact pathway. The exception is arsenic, where a surface soil concentration of 25 mg/kg has been determined to produce a carcinogenic risk of 10^{-5} , while a concentration of 2.5 mg/kg corresponds to an estimated 10^{-6} carcinogenic risk. Background levels of arsenic in the eastern United States average an estimated 7.4 mg/kg and range up to 73 ppm. In addition, the cancer of concern in this case is a non-fatal form of skin cancer. As a result, 25 mg/kg of arsenic in soil is considered to be protective and is the target cleanup level for this substance.

Table 11

**TARGET CONCENTRATIONS FOR CHEMICALS IN SOIL BASED ON
THE GROUNDWATER INGESTION PATHWAY AT THE GREENWOOD SITE**

CHEMICAL	CONCENTRATION mg/kg	CRITERIA
Arsenic	92	MCL
Benzene	0.083	MCL
Chlorobenzene	32	WQC
Cyanide	520	HA
Methylene chloride	0.1	Health-based (1×10^{-5} risk)
Semi-volatile TICs	580	Based on threshold toxicity
Total PAH (naphthalene)	5000	Based on threshold toxicity
Tetrachloroethene	0.07	WQC
Trichloroethene	0.13	MCL
Volatile TICs	1.0	Based on threshold toxicity.

MCL = maximum contaminant limit (See Table 12)

WQC = water quality criteria (See Table 12)

HA = EPA Health Advisory, Office of Drinking Water, 1987

IX. DESCRIPTION OF ALTERNATIVES

The Focused Feasibility Study (FFS) for the Greenwood Chemical Site developed and screened alternatives to address OU-1. Upon completion of the screening process described in the FFS, four alternatives were evaluated in detail. The No Action Alternative was evaluated as required by CERCLA. In addition, three alternatives involving both treatment and containment were evaluated. Unlike the No Action alternative, the three treatment alternatives strive to achieve previously identified remedial objectives. There are no operation and maintenance (O&M) costs associated with these three alternatives.

Alternative 1: No Action

Cost (Present Worth): \$529,900.
O&M Cost (Present Worth): \$462,600.
Implementation Time: Over 5 years

Under this alternative, no remedial action would be taken other than (1) groundwater and soil monitoring and (2) re-seeding of areas disturbed by Remedial Investigation activities. A program of periodic groundwater and soil monitoring would be implemented over the next 30 years to evaluate changes in site conditions over time. Because contamination of OU-1 soils will remain in place, collected monitoring data will be evaluated no less often than every 5 years as required by Section 121 (c) of CERCLA as amended. Similarly, the need for remedial action would also be evaluated every five years. Capital costs in this case cover installation of additional monitoring wells (if necessary).

Alternative 2: Excavation, Onsite Thermal Oxidation (Incineration), Solidification, and Offsite Disposal of Residuals

Cost (Present Worth): \$7,884,000.
Implementation Time: 18 to 30 months

Major Components: The major features include excavation of an estimated 4,500 cubic yards of contaminated soil associated with Lagoons 1,2 and 3, and Backfill North (OU-1), onsite thermal oxidation, onsite stabilization of treated residuals (if necessary), and/or transport of residuals to an offsite RCRA Subtitle C landfill. In addition, containerized chemicals would be treated and/or disposed of offsite.

Soils exceeding site-specific, risk-based cleanup levels would be excavated and treated onsite in accordance with RCRA Subpart O standards using a thermal oxidation unit. Where feasible, contents of contained chemicals would also be incinerated onsite. The unit would be mobilized, operated, and closed according to the requirements of RCRA Subpart O), 40 CFR 264.340.

These requirements are applicable because the soil contains a RCRA-listed waste. Specific operating practices necessary to meet the performance objectives, including a 99.99 percent destruction and removal efficiency (DRE) of stack emissions as required by Subpart O of RCRA, would be determined through a trial burn at the site after the installation of the thermal unit. Site-specific air modeling has determined that arsenic emissions from the thermal oxidation unit could present a risk to surrounding population without appropriate emission controls. Therefore, the unit would likely be equipped with a forced flux condenser and a high-energy collision scrubber to minimize the emissions of arsenic and the resultant risk.

Since the soils contain a RCRA-listed waste, the residuals from the treatment process would be disposed in a RCRA Subtitle C Landfill after compliance with applicable or relevant and appropriate RCRA Land Disposal Restrictions is confirmed. Because establishment of a Subtitle C landfill onsite is not technically feasible, an offsite disposal facility shall be used.

Transport of soil residuals must meet all standards applicable to transporters of RCRA hazardous waste (RCRA Sec. 3003, 40 CFR 262-263 and Virginia State Hazardous Waste Management Regulations), while the disposal facility must be in compliance with RCRA Subtitle C Landfill Standards per EPA procedures for implementing off site response actions (EPA Directive 9834.11). Contained chemicals which cannot be incinerated onsite shall also be transported offsite for treatment and/or disposal. All soils exceeding risk-based cleanup levels shall be excavated and removed from the site. Therefore, RCRA Clean Closure requirements will have to be met for all excavated areas by backfilling with clean soil, grading to promote drainage, coverage with topsoil, and revegetation to minimize erosion. (Ground water remediation necessary to complete RCRA Clean Closure will be selected under OU-2.) Since use of soils in the area of concern will be unrestricted, neither operation and maintenance nor a SARA five-year review will be necessary.

**Alternative 3: Excavation, Off Site Thermal Oxidation
(Incineration), and Off Site Disposal of Residuals**

Cost (Present Worth): \$8,787,900.

Implementation Time: 16 Months

Major Components: An estimated 4,500 cubic yards of contaminated soil associated with Lagoons 1, 2 and 3 and Backfill North would be excavated and transported to an off site thermal oxidation treatment facility. Following thermal oxidation, residuals would be stabilized (if necessary) and disposed in a RCRA Subtitle C landfill. Containerized chemicals would also be transported off-site for thermal oxidation and landfilling.

Soils exceeding risk-based cleanup levels would be excavated and transported in compliance with standards applicable to transporters of hazardous waste (RCRA Sec 3003 40 CFR 262-263 and Virginia State Hazardous Waste Management Regulations) to an incineration facility. The selected facility would be permitted and in compliance with all requirements applicable to RCRA incineration facilities, including 40 CFR 264, Sub-part O and CFR 270.124. Specific requirements would include a 99.99 percent destruction efficiency. If necessary, residual ash remaining after oxidation would be stabilized/solidified by the permitted facility prior to disposal in a RCRA Subtitle C landfill.

Excavated areas would be backfilled with clean soil, graded to promote drainage, covered with top-soil and revegetated. Due to removal of all soil exceeding risk-based cleanup levels, RCRA Clean Closure requirements for the excavated areas will be met. (Groundwater remediation necessary to complete RCRA Clean Closure will be selected under OU-2.) Since use of soils in the area of concern will be unrestricted, neither operation and maintenance or a SARA five-year review will be necessary.

Alternative 4: Excavation, On Site Enhanced Volatilization and Solidification, Off-Site Disposal

Cost (present worth): \$6,558,000.

Implementation Time: 36 to 48 months

Major Components: An estimated 4,500 cubic yards of contaminated soils associated with Lagoons 1,2 and 3 and Backfill North would be excavated and treated onsite in an enhanced, low-temperature volatilization treatment unit. Organic hydrocarbon residuals collected during treatment would be transported to an off-site thermal oxidation unit for destruction. Residual soils would be stabilized/solidified onsite (if necessary) and transported to an offsite RCRA Subtitle C Landfill for disposal. The landfill of concern would be in compliance with RCRA Subtitle C requirements per EPA procedures for implementing offsite response actions (EPA Directive 9834.11). Containerized chemicals would be transported offsite for treatment and/or disposal.

Available low temperature volatilization treatment systems are not known to be equipped with a forced flux condenser/high energy collision scrubber expected to be necessary to minimize arsenic emissions. As a result, these controls would have to be adapted to the treatment system of concern. In addition, bench and pilot scale tests would be necessary to confirm RCRA Land Disposal Restrictions (and corresponding treatment levels) will be met. Extensive tests would also be required to refine the design of the system.

Excavated areas shall be backfilled, graded and revegetated. Due to removal of all soil exceeding risk-based cleanup levels, RCRA Clean Closure requirements for the excavated areas will be met. (Ground water remediation necessary to complete RCRA clean closure will be selected under OU-2). Since use of soils in the area of concern will be unrestricted, neither operation and maintenance nor a SARA five-year review would be necessary.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

The four remedial action alternatives described above were evaluated using the following nine evaluation criteria presented in "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA, October 1988) and EPA Directive 9355, 3-20, "Draft Guidance on Preparing Superfund Decision Documents: The Proposed Plan and Record of Decision."

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)

Primary Balancing Criteria

- Reduction of toxicity, mobility, or volume
- Implementability
- Short-term effectiveness
- Long-term effectiveness
- Cost

Modifying Criteria

- Community acceptance
- State acceptance

These evaluation criteria relate directly to requirements in Section 121 of CERCLA which measure the overall feasibility and acceptability of the remedy. Threshold criteria must be satisfied (or an ARARs waiver obtained) in order for a remedy to be eligible for selection. Primary balancing criteria are used to weigh major trade-offs between remedies. State and community acceptance are modifying criteria formally taken into account after public comment is received on the Proposed Plan. The evaluations are as follows:

A. Protection of Human Health and the Environment

A primary requirement of CERCLA is that the selected remedial action be protective of human health and the environment. A remedy is protective if it reduces current and potential risks to acceptable levels posed by each exposure pathway at the site.

1. Onsite Thermal Oxidation, Offsite Thermal Oxidation

Both alternatives include excavation and incineration of all soils exceeding risk-based clean-up levels. Performance objectives for all operating incinerators, as required by Subpart O of RCRA, include 99.99 percent destruction. This objective is expected to be met in each case. Both incineration alternatives will be equally protective. In each case, residuals may be stabilized/solidified if necessary to immobilize metals prior to disposal. Onsite risks from direct contact and groundwater pathways would effectively be mitigated in both instances.

2. Enhanced Volatilization

All soils above risk-based clean-up levels shall be excavated for treatment. Enhanced volatilization is expected to significantly reduce concentrations of organic compounds, particularly the volatile fraction. Reduction efficiency for semi-volatile organics may not be as high as that for the incineration alternatives. Solid residuals from treatment would be disposed off-site. Onsite risks from direct contact and groundwater pathways would be effectively mitigated.

3. No Action

This alternative would not be protective of human health and the environment. In particular, contaminated soils would not be excavated, and risks identified previously would remain indefinitely. Based on this determination, the "No Action" alternative shall not be subjected to further evaluation.

B. Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State standards, requirements, criteria, and limitations (which are collectively referred to as "ARARs"). Applicable requirements (requirements which must be satisfied unless one of CERCLA's waiver provisions is justified) are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law which, while not applicable to the hazardous materials found at the site, the remedial action itself, the site location, or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to that site.

Significant ARAR's impacting the remedy selection process are discussed below.

1. Onsite Thermal Oxidation, Offsite Thermal Oxidation

Since the soils of concern contain RCRA-listed wastes (F002 and F005), RCRA Land Disposal Restrictions (including 40 CFR Section 268) addressing disposal of the excavated soil are applicable or relevant and appropriate. (See Section XI for more details). Thermal oxidation of the soils in an incinerator meeting RCRA Subpart O requirements is expected to produce a solid residue which meets all RCRA LDR. In each case, RCRA Subtitle C Closure requirements are applicable and would be met via excavation of all soils exceeding site specific risk-based clean-up levels. (Groundwater remediation shall also be required to complete RCRA Clean Closure.)

Each alternative is expected to meet all ARAR's under both the Clean Air Act (including 40 CFR Parts 1 to 99 and 40 CFR 61.01) and State of Virginia Regulations for the Control and Abatement of Air Pollution (where applicable).

2. Enhanced Volatilization

Prior to disposal of the excavated soil, RCRA Land Disposal Restrictions (LDR) must be met. After treatment via enhanced volatilization, the soil is likely to meet applicable treatment standards for volatile compounds described in 40 CFR 268 and other relevant and appropriate LDR criteria. An alternative LDR compliance option is to obtain a Treatability Variance (see EPA Directive 9347.3-06FS). Reduction of semi-volatile compounds to relevant and appropriate LDR criteria can only be confirmed through bench and pilot scale studies. Should contaminant levels in soils not be reduced per LDR ARAR's, the residual soil may have to be treated again via alternative means (e.g. thermal oxidation) before it can be disposed. While compliance with LDR cannot be confirmed at this time, excavation of all soil above risk-based clean-up levels will meet RCRA Subtitle C Clean Closure requirements for RCRA units of concern. (Groundwater remediation shall also be required to complete RCRA Clean Closure.) As in the case of the incineration alternatives, air emission ARAR's under both the Clean Air Act and Virginia Regulations for Control and Abatement of Air Pollution are expected to be met.

3. Reduction of Toxicity, Mobility, or Volume

This evaluation criteria addresses the degree to which a technology or remedial alternative reduces toxicity, mobility, or volume of hazardous substances. Section 121(b) of CERCLA establishes a preference for remedial actions that permanently and significantly reduce the toxicity, mobility, or volume of hazardous contaminants over remedial actions which would not result in such reductions.

1. Onsite Thermal Oxidation, Offsite Thermal Oxidation

Both alternatives will reduce the toxicity and volume of organic contaminants to the maximum extent possible. In particular, per requirements of Subpart O of RCRA, reduction efficiency will be at least 99.99%. If necessary, solidification/stabilization can reduce the mobility of metals prior to land disposal.

2. Enhanced Volatilization

The toxicity and volume of volatile organic contaminants are expected to be reduced significantly. Reduction efficiency for semi-volatile organics, is not expected to be as high and may be significantly less than that achieved via thermal oxidation. In the case of both volatiles and semi-volatiles, reduction efficiencies are not known at this time. If necessary, metals could be immobilized via solidification/ stabilization prior to disposal. Organic contaminants collected in the thermal volatilization unit will be destroyed offsite by means of thermal oxidation.

D. Implementability

Implementability refers to the technical and administrative feasibility of a remedy, from design through construction, operation, and maintenance. In all cases, coordination with the Virginia Department of Waste Management will facilitate implementability.

1. Offsite Thermal Oxidation

Several incinerators are already permitted under RCRA to treat the soils of concern. These facilities generally include RCRA Subtitle C landfills for disposal of solid residuals. While incinerator capacity is not high at this time, several new facilities within a reasonable distance of the site are expected to be on-line by 1990. This alternative employs proven technologies and is readily implementable.

2. Onsite Thermal Oxidation

Local residences are located as close as 400 feet upslope of the site. Due to the relative location of residences, arsenic emissions from an onsite incinerator are expected to require reduction which would likely be accomplished only via installation and operation of a forced flux condenser and collision scrubber. Installation and testing of this equipment is expected to take up to six months. While emission control efficiencies necessary to eliminate unacceptable risk to residents are expected to be achieved, these reduction efficiencies cannot be confirmed at this time. While more complex than offsite incineration, the remaining components of this alternative are implementable.

3. Enhanced Volatilization

Several mobile enhanced volatilization systems are available. However, the system most likely to be effective at reducing both volatile and semi-volatile hydrocarbons from the clay soil characteristic of Greenwood Chemical has not been equipped with air pollution controls expected to be necessary in this case. Up to a year of construction and testing would likely be necessary to install this equipment as needed. Bench and pilot scale testing would also be necessary to confirm the effectiveness of this alternative in meeting LDR and to refine the design of the system. At this time, enhanced volatilization has not been proven to be effective in reducing the concentrations of semi-volatile compounds unique to this site. Clay soils characteristic of the site may present technical problems, particularly with reduction of semi-volatile compounds.

E. Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to achieve protection of human health and the environment, and any adverse impacts that may be posed during the construction and operation period until cleanup goals are achieved.

1. Offsite Thermal Oxidation

There would be minimal impact to the community during implementation. Runoff shall be diverted away from areas of excavation as necessary. Air emissions would be limited to those generated during excavation. Risks posed by transport of the contaminated soil have been determined to be minimal even in the case of an accidental release in transport. Fugitive dust emissions could be readily minimized using water sprays and conventional engineering measures. Design of this alternative could take less than a year, with all soil excavated and transported to an offsite incinerator disposal facility within one-half year provided that adequate capacity existed.

2. Onsite Thermal Oxidation

The community residing in the immediate vicinity of the site would be exposed to low-level arsenic emissions from an onsite incinerator, particularly those residing upslope of the site. While special air pollution equipment is expected to minimize exposure to acceptable levels, delays may be incurred in getting the system on-line and during operation. These delays would result in additional contaminant releases to groundwater during the period of concern. Design and contractor procurement could exceed one year, while construction and implementation could also exceed one year.

3. Enhanced Volatilization

While arsenic emissions from a low temperature enhanced volatilization system could be lower than those from onsite thermal oxidation, special air pollution control equipment may still be required (forced flux condenser and high energy scrubber). Without effective air pollution controls, carcinogenic risk incurred by residents in the area may be up to 1×10^{-4} . This equipment would have to be specially adapted to the thermal treatment unit. After adaptation, pilot scale testing would be required to verify reduction efficiencies for arsenic emissions have been met. This process could take up to 6 months. In addition, bench and pilot scale tests would be necessary to confirm that LDR requirements were being met and to refine design parameters. Design could exceed one year, while construction and implementation time could exceed two years.

F. Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence addresses the long-term protection of human health and the environment once cleanup goals have been achieved, and focuses on residual risk that will remain after completion of the remedial action.

1. Onsite Thermal Oxidation, Offsite Thermal Oxidation

These alternatives should be equally effective in the long term. In each case, site-related organic contaminants are permanently destroyed to the maximum extent possible under current technology. If necessary, metals in solid residuals can be immobilized via solification/stabilization prior to disposal. A RCRA Subtitle C Landfill provides a disposal facility which should further limit the migration of any inorganic contaminants remaining in the solid residuals.

2. Enhanced Volatilization

This alternative is expected to meet LDR requirements for volatile organic contaminants. Reduction is not expected to be as efficient for semi-volatile compounds. In either case, bench and pilot scale studies will be necessary to confirm that LDR are met after treatment. If necessary, stabilization/solidification can reduce mobility of metals in the residuals prior to disposal. Chemical residuals from the process would undergo thermal oxidation in a RCRA-permitted incinerator. Semi-volatiles levels in solid residuals are expected to exceed that found in residuals after incineration. These semi-volatiles ultimately would have to be contained in the Sub-Title C landfill. Solidification/stabilization may help immobilize the semi-volatiles prior to such disposal.

G. Cost

CERCLA requires selection of a cost-effective remedy (not merely the lowest cost) that protects human health and the environment and meets other requirements of the statute. Project cost includes all construction and operation and maintenance costs incurred over the life of the project. An analysis of the present worth value of these costs has been completed for each alternative described in this Record of Decision, and is provided in Section IX. Capital costs include those expenditures necessary to implement a remedial action. Annual operating costs are included in the present worth cost.

Enhanced Volatilization, Onsite Thermal Oxidation, Offsite Thermal Oxidation

Enhanced volatilization is expected to be the least costly alternative to implement, assuming the volume of contaminated soil is 4,500 cubic yards. However, the effectiveness of this alternative would have to be demonstrated via bench and pilot-scale treatability studies. Both onsite and offsite thermal oxidation are proven to be effective. At a volume of 4,500 cubic yards, the estimated cost of offsite thermal oxidation exceeds the estimated cost of onsite thermal oxidation. The actual cost of these alternatives may be relatively equal. Should final volumes exceed current estimates, onsite incineration could be become relatively less expensive than offsite. Enhanced volatilization is likely to be the least costly alternative at all soil volumes above 4,500 cubic yards.

H. Community Acceptance

A local citizens group (Concerned Citizens for Greenwood) has strongly endorsed the selection of Off-Site Thermal Oxidation via written comments submitted in response to a Proposed Plan released on August 24, 1989. Additional verbal comments by local residents during a public meeting held on September 12, 1989 also preferred this alternative. Comments during the meeting are summarized in the Responsiveness Summary in this document. In no case did the community express preference for another alternative. Concern was expressed regarding any alternative resulting in the release of significant air emissions from the site.

I. State Acceptance

The Commonwealth of Virginia has selected Off-Site Thermal Oxidation as the preferred remedial alternative for the Greenwood Chemical Site.

IX. THE SELECTED REMEDY

Based upon consideration of the requirements of CERCLA and SARA, the detailed analysis of the alternatives, and public comments, the EPA has selected Off-Site Thermal Oxidation as the Preferred Remedial Action for addressing Operable Unit One of the Greenwood Chemical site. The Commonwealth of Virginia has concurred in the selection. This remedy is protective of human health and the environment, is cost-effective, meets or exceeds ARAR's and utilizes treatment technology to the maximum extent practicable.

The first primary objective of this remedy is excavation of all soil within Operable Unit One exceeding site-specific, risk-based cleanup levels. This volume is currently estimated at 4,500 cubic yards.

The site-specific, risk-based clean-up levels are identified in the Remedial Action Objectives section of this document. Upon excavation of all such soils and subsequent removal from the site, no soils within Operable Unit One (soils associated with Lagoons 1,2 and 3 and Backfill North) shall present an unacceptable risk to human health and the environment. In particular, soils within Operable Unit One shall no longer present a risk due to direct contact (dermal contact or incidental ingestion), nor will leachate migrating from these soils result in an unacceptable risk to consumers of groundwater receiving such leachate. To accomplish these objectives, all soils exceeding levels identified in Table 11 shall be excavated. In addition, soils with arsenic at concentrations of greater than 25 mg/kg shall be excavated.

Prior to excavation of the contaminated soil of concern, ditches, dikes, berms and/or other runoff/sediment controls shall be implemented. These controls would be in compliance with Virginia's Erosion and Sediment Control Law and are expected to minimize contact of runoff with OU-1 soil. Water collecting within excavated areas of OU-1 shall be treated as F002 and F005 RCRA listed waste (see below for rationale).

At this time, it is estimated that 4,500 cubic yards of soil shall exceed site-specific, risk-based cleanup goals and thus must be removed from the site. Soil sampling shall determine when clean-up objectives have been met and excavation may cease. Excavated soils would then be staged and screened onsite in compliance with RCRA regulations addressing waste piles (40 CFR 264.250-259). The screened soils shall then be transported to an off-site thermal oxidation/disposal facility. Transport would be in compliance with RCRA requirements applicable to transporters of hazardous waste and Virginia Hazardous Waste Management Regulations of July 1, 1988, which require that transporters of hazardous waste within Virginia possess a transporter permit issued by the Virginia Department of Waste Management.

All excavated/transported soils shall then be thermally oxidized, stabilized/solidified, and/or disposed in a RCRA Subtitle C Landfill. Available site information indicates that chlorobenzene and toluene have been used as solvent in chemical production processes onsite (see page 6). These spent solvents are categorized as RCRA-listed F002 and F005 wastes, respectively and are contained in soils of OU-1. Per RCRA Land Disposal Restrictions, and in particular, 40 CFR Section 268.41, this soil may be disposed in a RCRA Sub-title C Landfill only after the extract (see Subpart D, Appendix I) meets criteria identified in Table CCWE of 40 CFR 268.41.

Soils of OU-1 also contain significant concentrations of naphthalene, naphthalene derivatives, and numerous other semi-volatile TIC compounds. Naphthalene contained in the soil is not a RCRA listed waste. Therefore, LDR is not applicable with regard to naphthalene. However, the soil containing naphthalene is similar to RCRA-listed wastes K001 and K087, which also contain naphthalene and naphthalene derivatives. Therefore, naphthalene treatment standards for K001 and K087 in 40 CFR Subpart D are relevant and appropriate. These standards are 8.0 mg/kg and 3.4 mg/kg naphthalene respectively. In each case, the treatment technology used as a basis for developing the standards was thermal oxidation (or incineration). Therefore, prior to disposal, naphthalene concentrations should be reduced to 3.4 mg/kg (or the lower standard).

Thermal oxidation via incineration in a unit meeting RCRA Subpart O requirements will reduce organic contaminant concentrations in the soil by 99.99% and thus meet both applicable and relevant and appropriate LDR requirements. If necessary, the soil should be stabilized/solidified prior to disposal to meet RCRA characteristic waste criteria, particularly the criteria for arsenic (5.0 mg/l EP toxicity).

Chemicals stored in onsite process buildings shall also be incinerated/disposed offsite in compliance with LDRs. Excavated areas will be backfilled with clean fill, graded and revegetated. At this point, soils within OU-1 will no longer present an unacceptable risk to human health and the environment. No further maintenance of the area will be required to mitigate risk. (Therefore, there are no operation and maintenance costs.) At this point, a RCRA Clean Closure for the former RCRA units of concern will be complete. (Groundwater remediation necessary to complete RCRA Clean Closure will be selected under OU-2.)

The major components and associated costs of the selected remedy are summarized in Table 13, while ARAR's for the selected remedy are summarized in Table 12.

Table 12

ALTERNATIVE	ACTION-SPECIFIC AREAS	LOCATION-SPECIFIC AREAS	CONTAMINANT-SPECIFIC AREAS
C-3 (Off-Site Thermal Oxidation and RCRA Subtitle C, Landfilling)	Superfund Amendments and Reauthorization Act (SARA) OSHA - Safety and Health Standards 29 CFR 1910 and 1926 OSHA - Recordkeeping, Reporting, and Related Regulations 29 CFR 1904 Resource Conservation and Recovery Act (RCRA), Subtitle C, 40 CFR 260 RCRA - Standards for Owners Operators of Permitted Hazardous Waste Facilities 40 CFR 264.10-264.8 RCRA - Closure and Post-Closure 40 CFR 264.110-264.120 RCRA - Manifesting, Recordkeeping and Reporting, 40 CFR 264.70-264.77 RCRA - Landfills, 40 CFR 264, Subpart B RCRA - Land Disposal Restrictions, 40 CFR 268, Subpart D Hazardous and Solid Waste Amendments of 1984 (1984 Amendments to RCRA) PL 98-616, Federal Law 71:3101 Standards Applicable to Transporters of Hazardous Waste-RCRA Section 3003 40 CFR 262-263, 40 CFR 170-179 EPA Administered Permit Program: The Hazardous Waste Permit Program -RCRA Section 30 - 05 CFR 270.124 RCRA - Incinerators, 40 CFR 264, Subpart O RCRA - Incinerators, 40 CFR 270.19	Wilderness Act, 50 CFR 35.1 Fish and Wildlife Coordination Act, 40 CFR 6.302 Clean Air Act (CAA) - National Emission Standards for Hazardous Air Pollutants, 40 CFR 61.01 Clean Air Act (CAA) - MAQS 40 CFR 1 to 99 State of Virginia, Regulations for the Control and Abatement of Air Pollution, Rules 4-7, 4-16, 5-1, 5-3, 5-4 State of Virginia Hazardous Waste Management Regulations, July 1, 1988 State of Virginia, Proposed Solid Waste Management Regulations, Part II, Subpart C, July 1, 1988 *	RCRA, 40 CFR 261 RCRA, 40 CFR 264 Clean Air Act, National Ambient Air Quality Standards SDWA - Maximum Contaminant Levels (MCLs), 40 CFR 141.11-141.16 SDWA - Maximum Contaminant Level Goals (MCLGs), 49 CFR 141.50-141.51 Clean Water Act (CWA) - Water Quality Criteria Virginia State Water Control Law (Surface Water and Groundwater Quality Standards), Section 62.1, Chapter 3.1 Code of Virginia

* Promulgated January 9, 1989

Table 13

**CAPITAL & ANNUAL OPERATING COST ESTIMATE SUMMARY
ALTERNATIVE C-3: OFF-SITE THERMAL
OXIDATION AND RCRA LANDFILLING**

	<u>ESTIMATED QUANTITY</u>	<u>UNIT PRICE</u>	<u>COST (1989)</u>	<u>REFERENCES/REMARKS</u>
I. GENERAL ACTIONS/SITE PREPARATION				
1. Clearing and Grubbing	1.3 Acres	\$5,000/Acre	6,500	Reference 50. Cost per CY was adjusted.
2. Temporary Fences, Ditches, Dikes and Berms	1,000 LF	\$5/LF	5,000	Reference 50. Cost per CY was adjusted.
3. Temporary Staging Area and Sediment Control	2,500 SY	\$4/SY	10,000	Reference 50
4. Decontamination Facility	L.S.	--	10,000	
5. Administrative and Health & Safety Trailers	2 Months	\$4,000/Mo.	<u>8,000</u>	
SUBTOTAL			39,500	
II. CONTAMINATED SOIL TREATMENT				
1. Excavation, Including Clean Soil Covers in Lagoons 1 and 3	5,000 Tons	\$50/Ton	250,000	Reference 54. Cost per CY was adjusted.
2. Transportation Cost (to an EPA-Approved Disposal Facility)	4,500 Tons	\$225/Ton	1,012,500	Reference 52
3. Off-Site Thermal Oxidation and Landfilling	4,000 Tons	\$1,200/Ton	5,400,000	Reference 44. Also refer to footnote #3, Appendix C.
4. Decontamination and Disposal of Refuse	L.S.	--	200,000	
5. Pack, Manifest, Transport Off-Site Disposal of Chemicals	L.S.	--	<u>85,000</u>	
SUBTOTAL			6,947,000	
III. SUPPORTING ACTIVITIES				
1. Soil Sampling and Analysis for Soil Contamination Monitoring	50 Days	\$2,000/Day	100,000	Reference 43
2. Environmental Modeling and Studies	L.S.	--	150,000	Reference 44
3. Soil Sampling and Analysis for Background Monitoring	L.S.	--	50,000	
4. Additional Support Facilities for Processing and Landfill Operations	50 Days	\$850/day	<u>42,500</u>	Reference 44
SUBTOTAL			342,500	

CAPITAL & ANNUAL OPERATING COST ESTIMATE SUMMARY
 ALTERNATIVE C-3: OFF-SITE THERMAL
 OXIDATION AND RCRA LANDFILLING

	<u>ESTIMATED QUANTITY</u>	<u>UNIT PRICE</u>	<u>COST (1989)</u>	<u>REFERENCES/REMARKS</u>
IV. SITE CLOSURE				
1. Backfill and Regrading	4,500 CY	\$20/CY	90,000	Reference 50
2. Site Restoration	1.3 Acre	\$3,000/Acre	<u>3,900</u>	Reference 50
	SUBTOTAL		93,900	
	TOTAL DIRECT COST		7,422,900	
V. INDIRECT COST				
Health and Safety @ 10% *			101,000	
Bid & Scope Contingency @ 15%			1,113,000	
Permitting and Legal @ 5% *			50,000	
Engineering and Design @ 10% *			<u>101,000</u>	
	TOTAL INDIRECT COST		1,365,000	
	TOTAL CAPITAL COST		8,787,900	
VI. ANNUAL O&M			0	
VII. TOTAL PRESENT WORTH			8,787,900	

Note: * = Cost pertains to on-site activities only, \$1,010,400

Note: See Focused Feasibility Study for References

XII. STATUTORY DETERMINATIONS

The selected remedy meets statutory requirements of CERCLA and the NCP. The remedy is protective of human health and the environment, complies with applicable or relevant and appropriate requirements, utilizes permanent solutions to the maximum extent practicable, is cost effective, and satisfies the statutory preference for treatment which permanently and significantly reduces the volume, toxicity or mobility of hazardous substances as a principal element.

Protection of Human Health and the Environment

The selected remedy will provide protection via excavation and removal of all soils exceeding site-specific health-based levels. Removal of the soils of concern will reduce potential carcinogenic risk presented by the soils to within the 10^{-4} to 10^{-7} range, while hazard indices for non-carcinogens will be reduced to less than one. Conventional engineering controls will prevent any short-term risks during excavation.

Compliance with Applicable or Relevant and Appropriate Requirements (ARAR's)

The selected remedy will comply with all ARARs of concern. By removing soils which exceed health-based clean-up levels, contaminant loading to groundwater will be reduced to a point where MCL's, WQC, or health based criteria are achieved. Since the excavated soil will contain RCRA listed wastes F002 and F005, applicable or relevant and appropriate RCRA LDRs will be met prior to disposal. Removal of all soil exceeding health-based levels will meet RCRA Clean Closure requirements for Lagoons 1, 2 and 3 and Backfill North upon implementation of a groundwater remedy (part of OU-2). See Section X, Selected Remedy, and Table 13 for a more detailed discussion of ARAR's.

Cost Effectiveness

The selected remedy affords overall effectiveness proportionate to its costs. While enhanced volatilization is expected to be less costly, reduction of semi-volatiles to criteria of concern cannot be confirmed at this time. While the estimated cost of Onsite Thermal Oxidation is less than the estimated cost of Offsite Thermal Oxidation, the actual cost of these alternatives may be relatively equal. Onsite Thermal Oxidation does not provide the short-term effectiveness (see below) of the selected remedy and is not as implementable.

Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The selected remedy provides the best balance of tradeoffs among the alternatives with respect to the evaluation criteria, particularly the five primary balancing criteria. In addition,

technologies to the maximum extent practicable.

Offsite Thermal Oxidation and Onsite Thermal Oxidation are equally effective in the long-term and are both permanent remedies. Enhanced volatilization is not known to be as effective in the long-term, particularly with regard to reduction efficiency for semi-volatile organics. Should significant concentrations of semi-volatiles remain in residuals after Enhanced Volatilization, this alternative would not be as permanent. Similarly, while Offsite and Onsite Thermal Oxidation reduce the toxicity, mobility or volume of organic contaminants to the maximum extent possible, Enhanced Volatilization may not reduce semi-volatiles to the same extent.

Offsite Incineration is the most readily implementable alternative. While incinerator capacity does not meet demand at this time, capacity should be adequate at the time of the Remedial Action. Onsite Thermal Oxidation is implementable. However, special pollution controls (a forced flux condenser and high energy collision scrubber) would likely be installed to minimize arsenic emissions and resultant risk. These controls are not available on mobile incinerators at this time and would have to be installed on such a unit as part of this remedy. Design, installation and testing of these controls will likely result in a longer implementation time than that for Offsite Thermal Oxidation. In addition, continuous monitoring would be necessary during Onsite Thermal Oxidation to confirm effectiveness of arsenic emission controls. Due to the expected longer implementation time, Onsite Thermal Oxidation would not be as effective in the short term. Similarly, Enhanced Volatilization is expected to require similar air emission controls. Associated emission control tests would supplement bench and pilot-scale tests necessary to confirm the effectiveness and design of Enhanced Volatilization. In any case, risk to residents from air emissions generated at an offsite thermal oxidation facility are expected to be insignificant.

Overall, Offsite Thermal Oxidation is the selected remedy due to its implementability and short-term effectiveness. Design and construction of special air pollution controls will be unnecessary and associated potential delays avoided. Operational problems relating to control of emissions with this equipment will be eliminated as well as resultant carcinogenic risk to residents in the vicinity of the site.

The community surrounding the site strongly favors the selection of an offsite treatment alternative. The community has expressed concern regarding exposure to emissions from an onsite treatment unit. The community also favors performance of the remedy as soon as possible. As discussed previously, delays may be incurred during the design and implementation of both onsite treatment remedies. Based on the above considerations, EPA has selected Off-Site Thermal Oxidation as the remedy. The Commonwealth of Virginia concurs in this selection.

Preference for Treatment as a Principal Element

The selection of Offsite Thermal Oxidation satisfies the statutory preference for treatment which permanently and significantly reduces the volume, toxicity or mobility of hazardous substances as a principal element of the remedy.

GREENWOOD CHEMICAL SITE
ALBEMARLE COUNTY, VIRGINIA
OPERABLE UNIT ONE

RESPONSIVENESS SUMMARY

This Responsiveness Summary is intended to document public concerns and comments expressed during the public comment period regarding Greenwood Chemical Site Operable Unit One (OU-1). The summary also documents EPA's responses to the comments and concerns that were received. Information is organized as follows:

- 1.0 Overview
- 2.0 Summary of Comments and Responses
- 3.0 Remaining Concerns

Attachment:

List of Community Relations Activities
Conducted at the Greenwood Chemical Site

1.0 OVERVIEW

Superfund Remedial Actions associated with cleanup of the Greenwood Chemical Site will be conducted in stages known as Operable Units (OUs). EPA recently completed and released a Focused Feasibility Study (FFS) and a Proposed Plan for OU-1 which addresses contaminated soil associated with four former lagoon locations and a backfill area, and drums/containers of chemicals remaining in onsite buildings.

A public comment period on the FFS and Proposed Plan for OU-1 began on August 24, 1989, and at the request of the local citizens' group, extended until October 24, 1989. The comment period, as well as the local availability of copies of the FFS and Proposed Plan, were announced to the community-of-concern in the Charlottesville Daily Progress on the first day of the public comment period. The announcement also provided information about a public meeting to discuss these documents. The meeting, held on September 12, 1989, was attended by approximately 40 people.

2.0 SUMMARY OF COMMENTS AND RESPONSES

GENERAL OBJECTIVE AND CLARIFICATION OF OPERABLE UNIT 1 (OU-1)

1. In reference to the Proposed Plan, what area is involved when the term "onsite" is used?

EPA Response: (Spokesman referred to a large display map while answering the question.) "Onsite" refers to the area of the facility property or approximately five acres.

2. EPA is proposing to spend about \$8 million on the cleanup of OU-1. What is EPA planning to do to protect the interests of people who don't live close to the site? Is the Agency going to spend that money to make a five-acre plot habitable or spend the money to protect all of the people living in surrounding areas?

EPA Response: EPA policy is to render the groundwater both under and around the site drinkable. The 1.5 acres of OU-1 comprise the portion of the site with the highest levels of soil contamination. Addressing this area will eliminate a major groundwater contaminant source. If the source is eliminated, additional contaminants can no longer migrate into the groundwater. Consequently, though EPA may spend money on actions that will occur in the relatively small area of OU-1, these actions should benefit the entire surrounding area.

EPA will perform additional groundwater monitoring following implementation of the proposed remedial action to determine the impact of contaminated soil removals. It is possible that a pocket of contaminated groundwater could remain after soil removal. If this is the case, EPA will undertake a remedy, such as pumping the contaminated groundwater out of the ground and treating it. A decision regarding groundwater will be made in the follow-up activities that EPA expects to conclude in about a year.

TYPE OF CONTAMINATION AND EXTENT OF MIGRATION

1. Are the primary soil contaminants volatile organics or metals?

EPA Response: Volatile and semi-volatile organics are generally a concern in cases of groundwater contamination. At this site, the organics in the soil are migrating to the groundwater and constitute a primary groundwater problem. Metals in the soil present a problem via direct contact.

Due to the high clay content of the soils, the metals are not migrating into groundwater to a significant extent.

Elevated metals are not appearing in groundwater at this time. Also, the soil contamination is localized in the area of the former facility and elevated concentrations of site-related metals have not been detected in offsite soils.

2. Do contaminants in the groundwater become less concentrated with distance from the site?

EPA Response: As expected, concentrations of site-related contaminants decline with distance from the primary sources of contamination. For instance, a monitoring well onsite has high levels of contamination, but those levels decrease significantly at a point 500 feet downgradient of the well. Contaminants have not been detected in residential wells downgradient of the site (approximately 2,000 feet away). This is the dilution effect. Groundwater flow from the mountain behind the site helps dilute contaminant concentrations.

3. Does EPA maintain any downgradient monitoring wells off site?

EPA Response: The monitoring well farthest downgradient of OU-1 is about 500 feet southeast of Lagoon 5. At that point, contaminant levels are low enough that the groundwater is almost drinkable. There are no monitoring wells downgradient of this point. However, there are downgradient residential wells that may be sampled periodically as part of EPA's ongoing activities.

4. How far has contamination spread?

EPA Response: A monitoring well located 500 feet southeast of Lagoon 5 contained detectable concentrations of some contaminants, but at a well about a half mile downgradient of the site, no contaminants have been detected. Therefore, contaminants have migrated to a point between 500 feet and one-half mile from the site.

EPA has installed about 25 monitoring wells. Additional wells might help further define the contaminant plume, but EPA may determine the extent of contaminant migration by using groundwater modeling. Modeling uses available information about the site to predict how far contamination will migrate.

5. From May through July 1989, Albemarle County had the highest rainfall ever recorded for this area. The ground was saturated, and there was a lot of runoff. Do conditions like this increase the spread of contamination?

EPA Response: There are various theories regarding this question. When the water table is low, there is less water available to dilute contamination. When there is significant precipitation, there is more opportunity for soil contaminants to migrate to groundwater.

(The speaker suggested that EPA should resample residential wells soon.)

FINANCIAL LIABILITY ASSOCIATED WITH CLEANUP

1. What does the term "responsible party" mean? Does it imply liability for cleanup costs?

EPA Response: Responsible parties (RPs) are all those who have been determined to be at least partially responsible for the contamination of a site. These parties may include past and present owners, generators and transporters of the hazardous substances of concern. EPA has identified some potentially RPs associated with this site, but additional potentially RPs may still be confirmed.

Routinely, under Superfund, those responsible for creating a problem are given the opportunity to take corrective actions. If they decline to do so, EPA undertakes the action using Superfund money. RPs are held liable for any cleanup costs incurred by EPA, however, and EPA will take legal action to recover those funds.

2. What are the State's financial responsibilities for this type of cleanup action?

EPA Response: The State is responsible for 10 percent of all cleanup costs, under Superfund.

SITE-RELATED RISKS ASSOCIATED WITH THE SITE

1. If 10,000 people spent their lives drinking the groundwater under the site, how many of them could expect to get cancer?

EPA Response: An estimated one in 10,000 people consuming onsite groundwater may contract cancer according to a Baseline Risk Assessment performed by EPA.

2. Could water fowl that stop at the site spread contamination to other areas nearby?

EPA Response: This is a remote possibility. EPA's concern is not that animals using the site might spread contamination. Rather, the Agency's concern is for the effect of the site on the health of the animals.

3. What risks would be associated with airborne contaminants released during soil excavation and transportation activities?

EPA Response: The short-term effects of remedial activities are a primary concern of EPA, and airborne particles will be taken into account during remedial design. There are various methods available to control air transport of contaminants, and every effort will be made to do so. The specific method will be selected during the design phase.

AVENUES FOR PUBLIC PARTICIPATION

1. Who is presenting Greenwood's case to those who will decide which sites get funding to proceed with remedial actions? Who is the community's advocate with EPA?

EPA Response: Several people, including the Remedial Project Manager, work together to present Greenwood's case to EPA Headquarters. The State is also involved in this effort because of its responsibilities under Superfund. However, the public comment period is an excellent opportunity for the community to join the effort to draw attention to its needs and concerns regarding this site.

The Community Relations Coordinator (CRC) for the site is the primary contact for the public within the Agency. Whenever questions or concerns arise, interested parties may contact their CRC, the CRC will bring their concerns to the attention of the appropriate people.

2. Should community members attempt to enlist the help of their Congressmen to get funding?

EPA Response: The time to contact your Congressman is when the Superfund Bill is proposed for reauthorization.

REMEDIAL ALTERNATIVES FOR OU-1

1. If EPA selected Alternative C-1, No Action, what would happen? Would groundwater downstream become increasingly contaminated?

EPA Response: If no action is taken, soil contamination will continue to migrate to groundwater.

However, it is not necessarily true that downgradient groundwater will become increasingly contaminated. EPA does not have reliable, historical groundwater data for this site. All of EPA's data has been obtained over the last few years, since the Agency's remedial investigations began. There is no information available to indicate what groundwater quality was like during the facility's peak operating years in the 1970s. Therefore, it's impossible to say whether contamination levels are increasing or decreasing. It is likely, though, that groundwater contaminant levels are decreasing because the facility is no longer operating and discharging wastewater into the lagoons. This means the contaminant source is no longer being replenished.

2. The preferred alternative, Alternative C-3, is offsite incineration. Where is the incinerator located, and will EPA use the nearby railroad as a means of transporting excavated soils off site? Transportation costs are a considerable portion of the remedial expense, and money is a valid concern.

EPA Response: The specific incinerator that will be used has not been identified, yet. The facility will be determined during the design phase. Incineration facilities will be given an opportunity to bid to provide the necessary goods and services.

Costs are important. Transportation costs are a major consideration, and rail transport could be built into the remedy, if it is found to be the best choice. EPA will certainly keep the railroad's proximity to the site in mind.

3. Does the 16-month period of performance associated with the preferred alternative for OU-1 include the design phase, or does it begin when the onsite work begins?

EPA Response: Assuming funds are available, the period of performance begins when the Record of Decision is signed.

4. Do the Operable Units proceed concurrently?

EPA Response: They do. Within a year, EPA expects to have another Proposed Plan that will address the rest of the site.

5. What "pressure" is EPA bowing to by moving rapidly on just one of the operable units identified at the site? Will completing cleanup actions for OU-1 remove the majority of site-related risks?

EPA Response: Cleaning up OU-1 will address a principal threat at the site, and EPA has sufficient documentation to support the decision to take action at this time. There is no reason to wait.

6. The community is applying for a Technical Assistance Grant (TAG), but hasn't received one at this point; so, no consultant has been hired to review EPA reports. Yet, EPA has taken this "extra" action (OU-1). Is a response still required by October 24, 1989?

EPA Response: Yes, a response is required by the close of the comment period. There is no way of knowing when the community will receive TAG money.

7. When will EPA know if funding is available to implement the Proposed Plan for OU-1? Can you predict a likely schedule for receiving funds?

EPA Response: It's very difficult to say when funds will be available for Greenwood. There is a sum of money available for this type of action, but there are many sites across the country vying for attention. The comment period is a good time for the public to attempt to influence funding decisions. Because more sites may be ready for cleanup than there is money available to fund the work, environmental prioritization of sites will be necessary for the upcoming fiscal years until Superfund is reauthorized.

When the remedial design for this site is 90 percent completed, the site will be prioritized. That will determine whether funds to proceed will be made available. If the site is below the funding line, it will become part of the "queue" of waiting sites. If a site remains in the queue for a year, it automatically receives more priority points. So, it is unlikely a site will remain in the queue for two years in a row. Unfortunately, there is no good way to estimate when the site will be acted on. Region III will simply continue to move forward on this site.

Of course, if the RPs agree to undertake the cleanup action, prioritization will not be a factor, and the cleanup will proceed as soon as possible.

COMMENTS IN SUPPORT OF THE PREFERRED ALTERNATIVE

1. A resident stated that EPA's preferred alternative appears to be the "most advantageous" alternative for the local community and for all of Albemarle County. The speaker also said that this choice is "far superior" to the other options under consideration.
2. Another resident stated that, although people have expressed concern about remedial costs versus the level of risk associated with the site, it should be remembered that the community has an ethical responsibility to its children, and to all those who are yet to come, to see that this site is cleaned up. This speaker said that this matter is not about a specific five-acre plot of land but, rather, should be viewed as a global concern. He applauded Superfund and the EPA for developing this kind of program.
3. One written comment was received during the public comment period. The letter was from the president of the Greenwood Citizens' Council who stated that the group is overwhelmingly in favor of EPA's preferred alternative, Alternative C-3. This writer urged EPA to expedite the design and remediation of OU-1, while also fast-tracking the remainder of the remedial investigation.

3.0 REMAINING CONCERNS

Although the community is in agreement with EPA's Proposed Plan, two areas of concern not covered by the plan remain.

1. The status of onsite buildings is a concern. Are they contaminated, and will they be removed?

EPA Response: That is undetermined at this time. The buildings will be addressed in the ongoing study, and a decision should be reached within a year.

2. It was suggested that downgradient residential wells should be resampled soon to allay concerns about contaminant migration that may have occurred during unusually heavy summer rains.

EPA Response: Periodic offsite monitoring is expected to continue.